A

Mathematical Companion,

Or the

DESCRIPTION and USE

Of a NEW

SLIDING-RULE,

BY WHICH

Many Useful and Necessary *Questions* in

Arithmetick,	*Geography,*
Military Orders,	*Astronomy,*
Interest,	*Navigation,*
Trigonometry,	*Fortification,*
Planometry,	*Gunnery,*
Stereometry,	*Dialling,*

May be speedily Resolved, without the help of *Pen*, or *Compasses.*

By WIL. HUNT, *Philomath.*

Omne tulit Punctum qui miscuit utile dulci.

London: Printed by *B. M.* for *R. Wellington*, at the Lute in St. *Paul's* Church-Yard. 1697.

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B L

To the

Truly Honourable

CHARLES MOUNTAGUE, Esq;

A MEMBER of the Honourable

House of Commons,

AND

JAMES MOUNTAGUE, Esq;

BRANCHES

OF THE

ILLUSTRIOUS FAMILY

OF

SANDWICH,

THIS

Mathematical Companion

AS A

Monument of Gratitude,

IS

Offer'd, Dedicated, Presented,

By the

AUTHOR

TO THE READER.

IF *it were the Custom of my* Brethren *to Carp at every thing that is not the Issue of their own Brains, then I might justly be discouraged from appearing in this manner; But being throughly perswaded of their Candor, that they will not condemn any thing which tends to the encrease of their knowledge, or Improvement of the* Revenue, *and that the* Criticisms *of the* Envious *are not prejudicial to Books of this Nature; It being a Subject that has employ'd the Pens of many learned and eminent Men, as* Euclid, Archimedes, *the noble Lord* Napier, *and of late Dr.* Isaac Barrow, *Mr.* Isaac Newton, *Dr.* John Wallis, *&c. Upon these Considerations I have adventured to Publish this*

Treatiſe. *If it doth not ſatisfie the Curious in every Point, yet this he may be aſſured of, that there is ſomething* New, *and that my Endeavours have not been wanting in the Collections, my Deſign being to render it an uſeful and neceſſary* Companion, *not only for* Gaugers *and* Artificers, *but for* all other Perſons *that Delight in* Mathematical Concluſions.

And in order thereto I have under proper and diſtinct Heads (and not promiſcuouſly) given variety of Problems *and* Examples *in* Arithmetick, Military Orders, Intereſt, Trigonometry, Planometry, Stereometry, Geography, Aſtronomy, Navigation, Fortification, Gunnery *and* Dialling; *Not that I pretend to write a* Courſe *of the* Mathematicks, *but only to ſhew the various Uſes of the* Lines *on the* Rule. *I expect not Immunity, but be not too Cenſorious, and it may be an encouragement for me to ſerve you hereafter upon ſome other as Profitable a Subject. Farewel*

Maidſtone Feb. 11. 1696. W. H.

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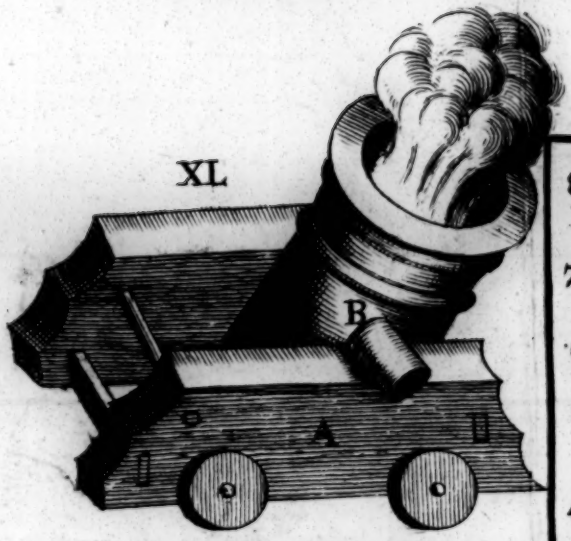

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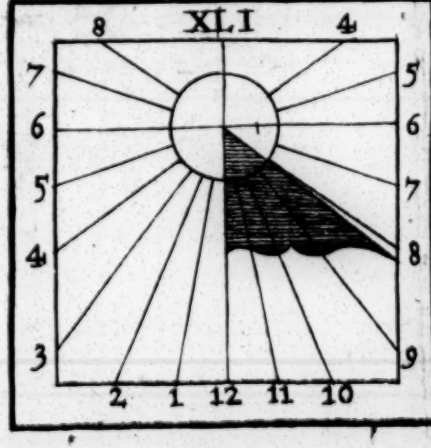

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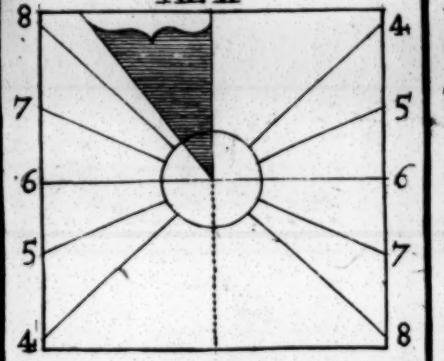

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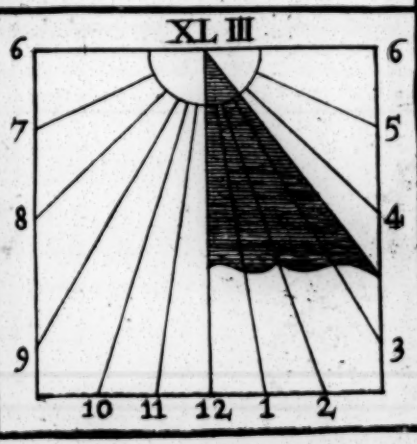

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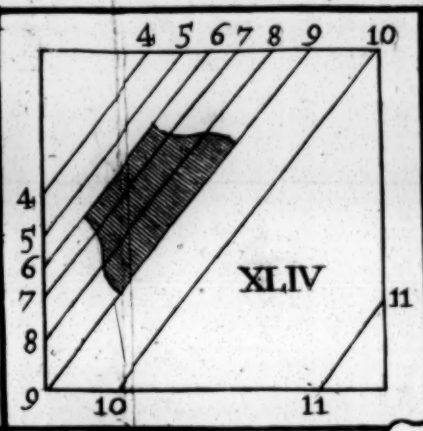

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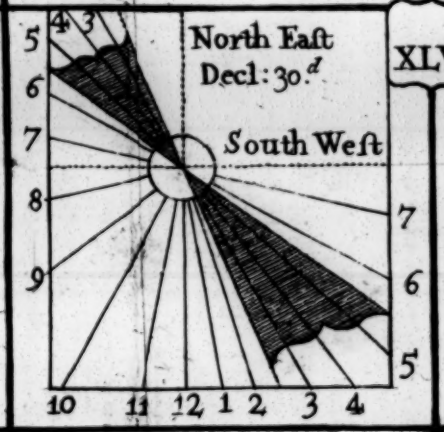

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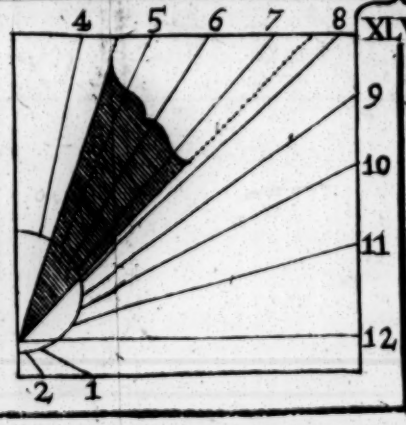

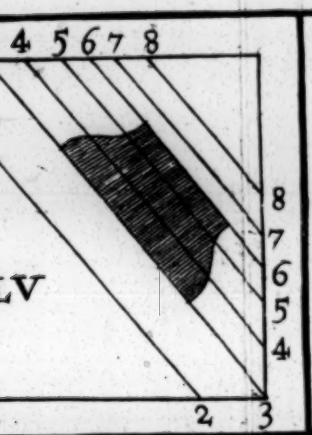
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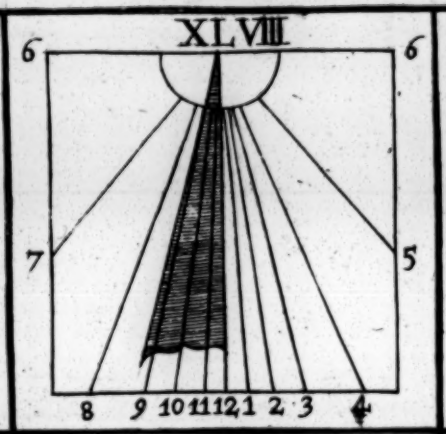
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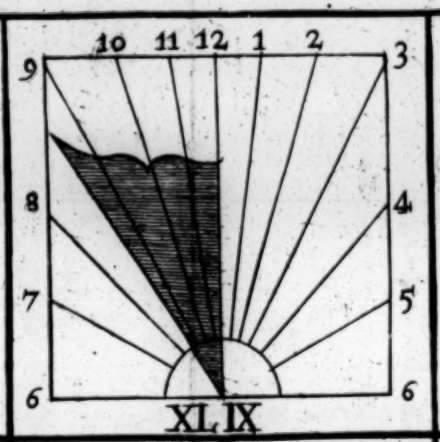
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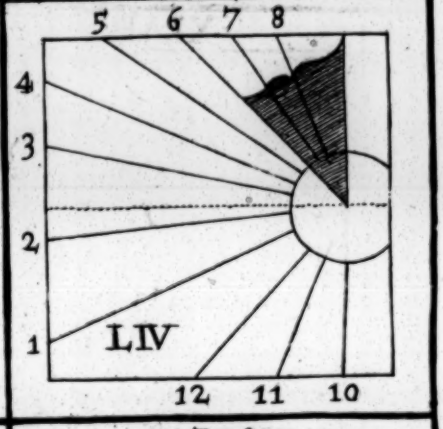
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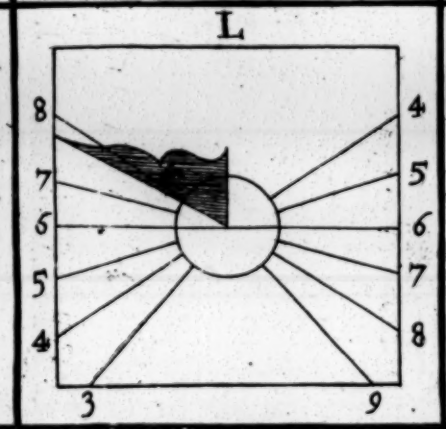
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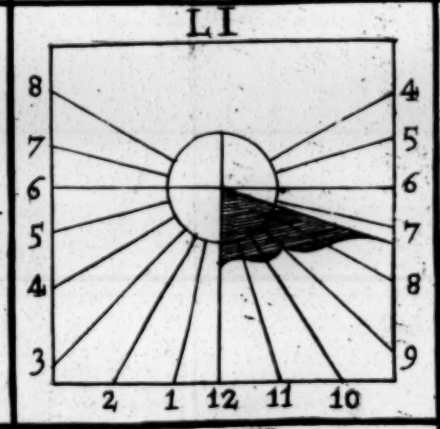
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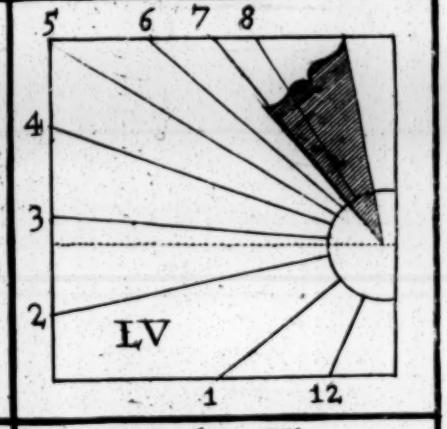
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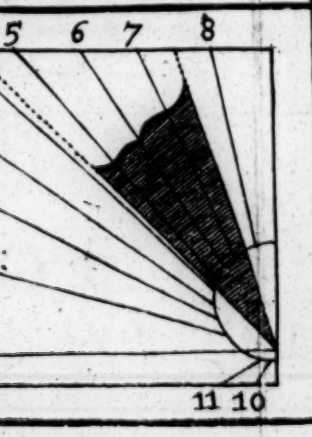
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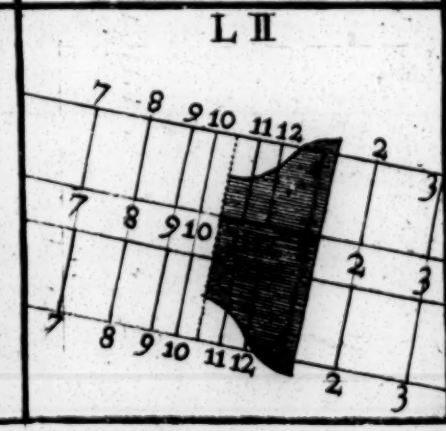
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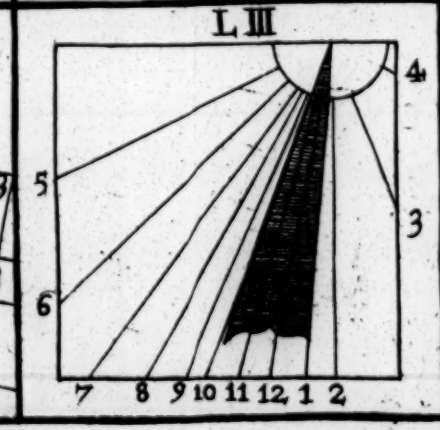
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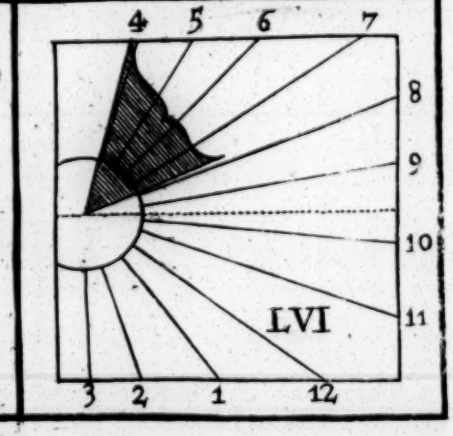
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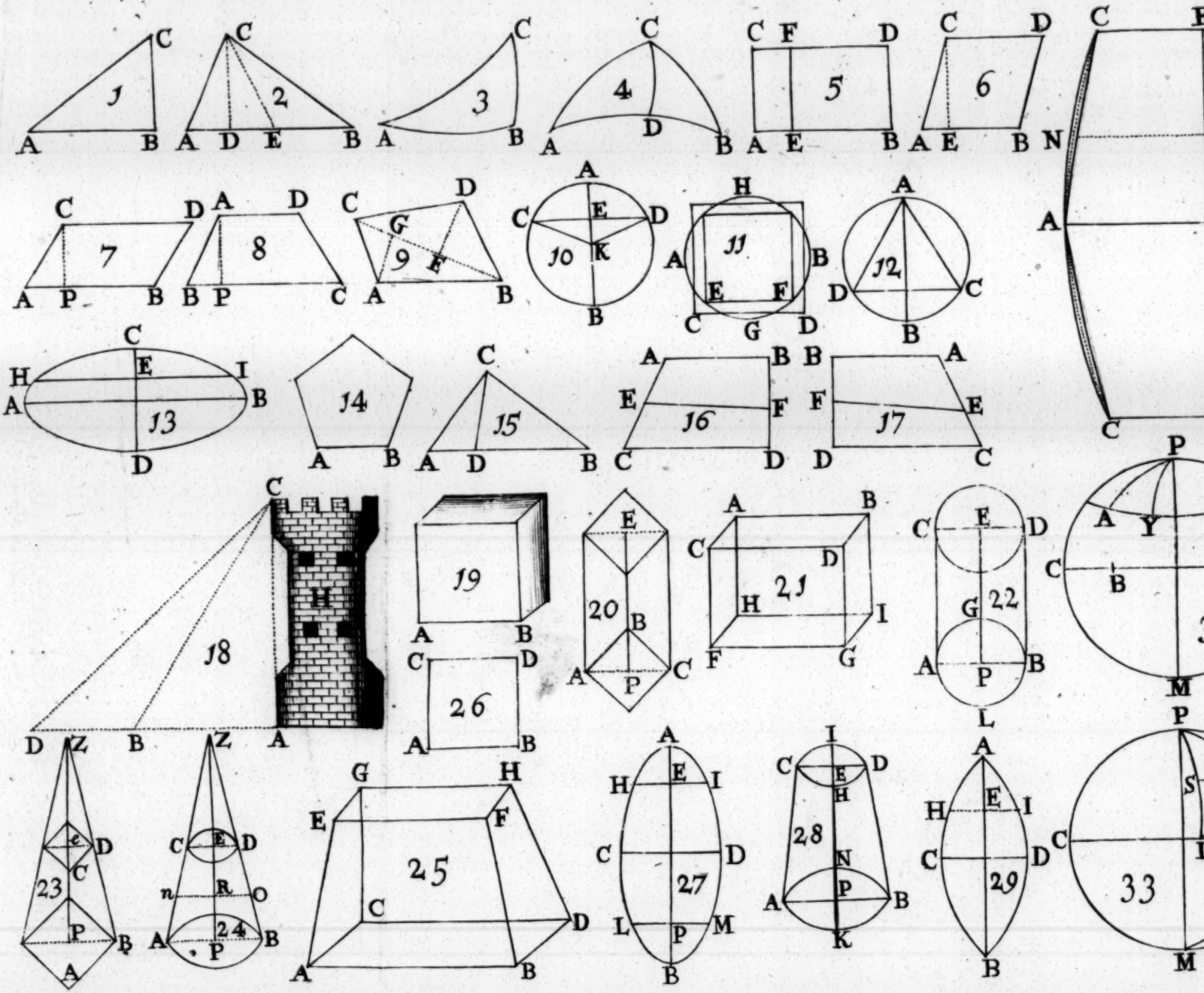
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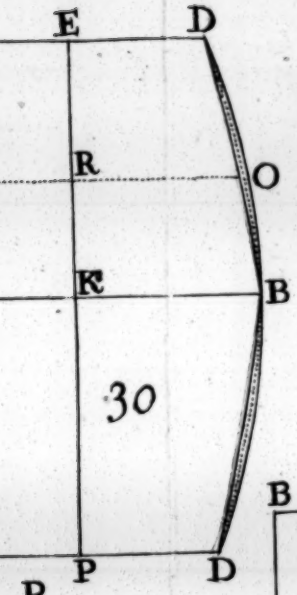
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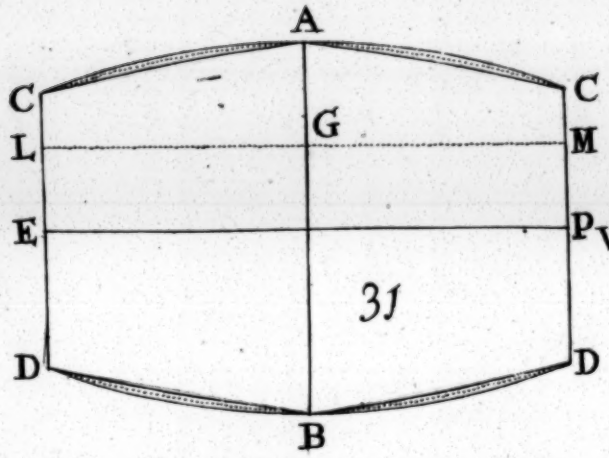
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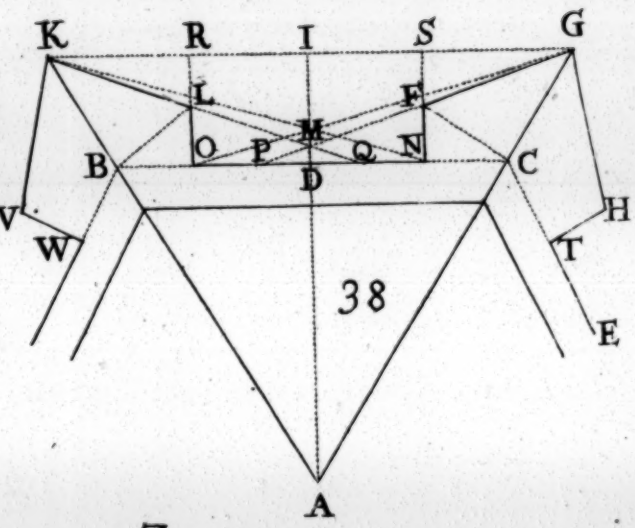
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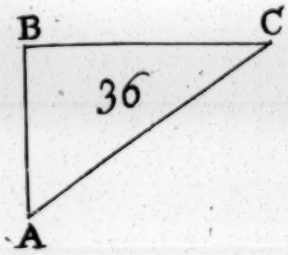
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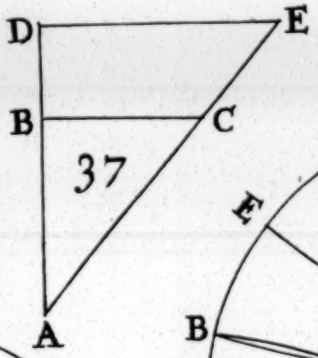
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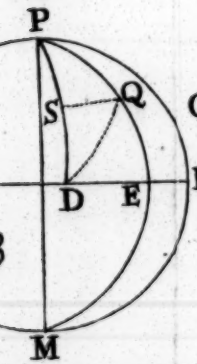
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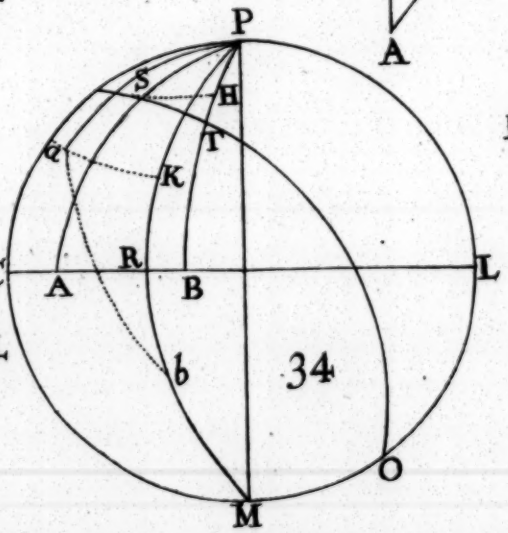
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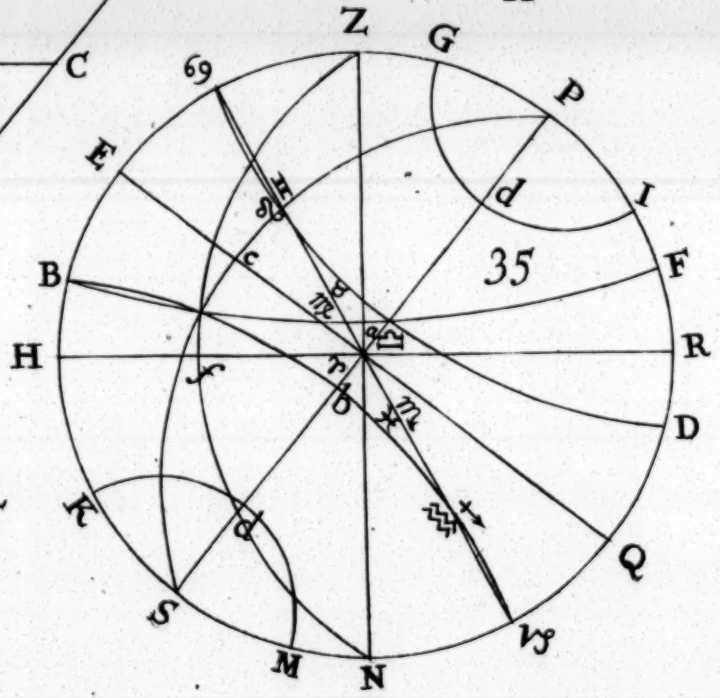
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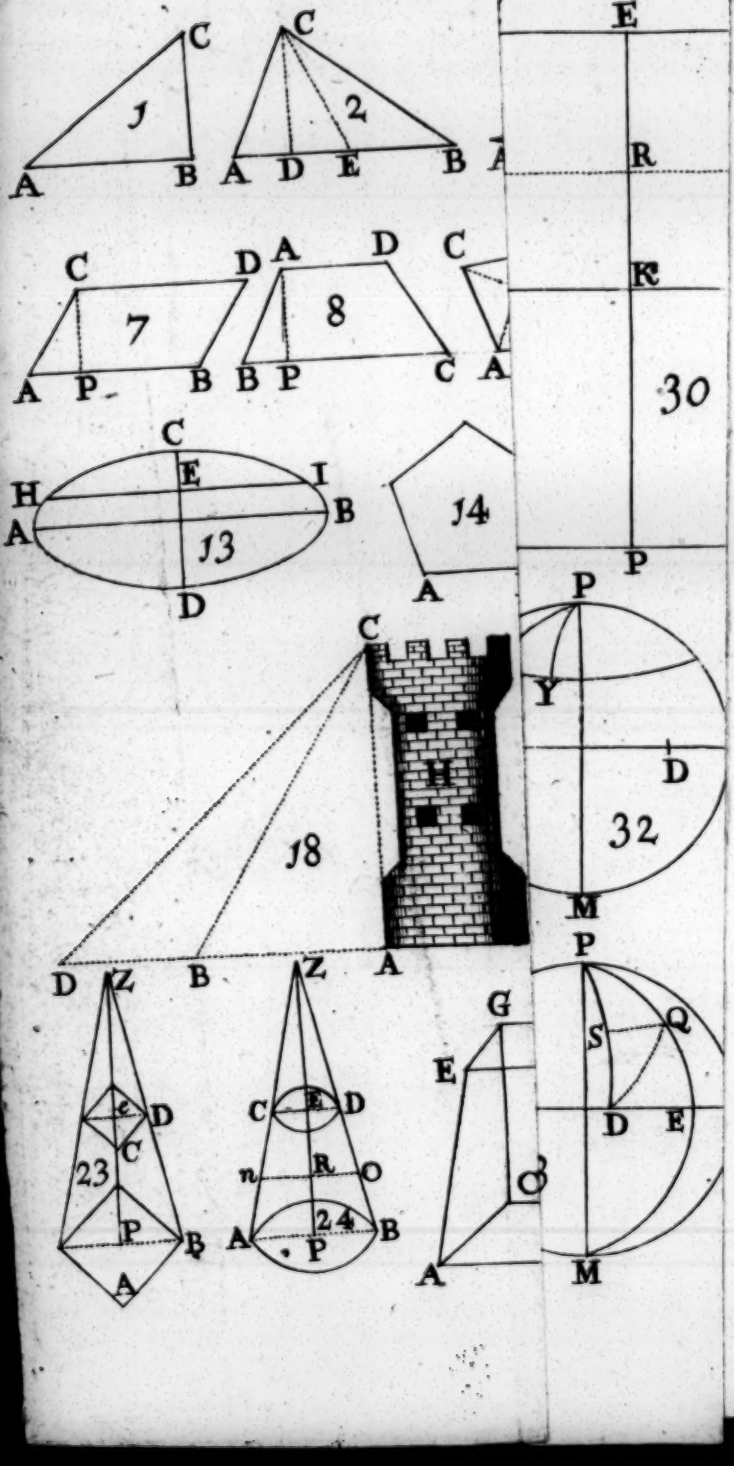
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THE
DESCRIPTION and USE
Of a NEW
SLIDING-RULE.

CHAP. I.

§. 1. *Description of the Rule, and the several Lines upon it.*

THIS *Rule* consists of three Peices, *viz.* One fixed, called the *Stock* (which is twelve Inches long) in which the other two *Slide*, and the *Lines* graduated thereon are these:

1. Upon one *Edge* on the *Stock* is a *Double Line of Numbers* marked D, and a *Triple Line of Numbers* marked E.

And on the *First Side* of this *Slider* are two *Single Lines of Numbers* marked C, one Facing D, and the other Facing E.

On the *Second*, *Third*, and *Fourth Sides*, are six Lines of *Segments*, *viz.* Three for the three *Forms*

of Casks in the *Clavis Stereometriæ*, Lying, marked 1.*L*; 2.*L*; 3.*L*; to Slide by D, and Three for the three *Forms of Casks* Standing, marked 1.*S*; 2.*S*; 3.*S*; to Slide by A.

II. Upon the opposite *Edge* on the *Stock* is a *Line* of *Artificial Sines* marked SS, and a *Double Line of Numbers* marked A.

And on the *First Side* of this *Slider* is a *Line* of *Sines* marked S, Facing SS, and a *Double Line of Numbers* marked B, Facing A.

On the *Second Side* is a *Line of Tangents* marked T, to Slide by SS, and a Line for finding the *Perifery of an Ellipsis* marked ⬭, to Slide by A.

On the *Third Side* are two *Lines of Segments*, one of a *Cone*, marked △, Facing D, the other of a *Parabolick Spindle* Standing, marked ( ) Facing A.

On the *Fourth Side* are two *Lines of Segments*, one of a *Sphere* marked ●, to Slide by D, the other of a *Circle* marked ⊙, to Slide by A.

III. *Upon one Flat are these Lines:*

1. *Foot Measure.*
2. *Decimal Inches.*
3. 4. 5. 6. } *Mean Diam. for the* { *First or Spheroidal* / *Second* / *Third* / *Frustum of a Cone.* } *Form of Casks.*

IV. *Upon the opposite Flat are these Lines:*

1. *A Meridian Line, or Line of Latitudes.*
2. *Equal parts, or Deg. of Long. answerable thereto.*
3. *Rumbs, Equal parts, and Leagues.*
4. *Chords, Miles of Longitude, and large Chords.*

5. *Versed*

5. *Verſed Sines, Hours, and Latitudes.*
6. *Right Sines, and Secants.*
7. *Tangents.*
8. *Semi-Tangents.*

Theſe *natural Sines, Tangents, and Secants,* and the other *Circular Scales or Lines,* are fitted to one and the ſame *Radius,* and conſequently may be uſed joyntly one with another.

V. Upon the *Stock* under the two *Sliders* is a *Line of Inches,* reaching on one ſide from 13 to 24, and on the other from 25 to 36, againſt which is a *Line of Areas of Circles in Ale Gallons.*

SS	SS	SS	SS	D	D	D	D
●	ϑ	T	S	3.L	2.L	1.L	C
○	()	⬭	B	3.S	2.S	1.S	C
A	A	A	A	E	E	E	E

§. 2. *Deſcription of the Line of Numbers,* &c.

The *Line of Numbers,* commonly called *Gunter's Line,* is only the *Logarithms* graduated on a *Rule* by a *Scale of equal parts* of the ſame length with the intended Line, and is divided firſt into 9 unequal parts called *Primes* marked 1, 2, 3, 4, 5, &c. each of theſe *Primes* is ſubdivided into 10 parts called *Tenths,* and each of theſe *Tenths* into 10 other parts called *Centeſms,* and each of theſe *Centeſms* is ſuppoſed to be divided into 10 other parts called *Millions.*

As on the Line C from 1, 2, 5 to 2, 5, 10 Every *Tenth* is ſubdivided into 10, 5, 2 Parts each denoting 1, 2, 5 *Centeſms.*

A 5 But

But on the Line D from { 1, 3, 6 } to { 3, 6, 10 } Every *Tenth* is ſub-divided into { 5, 2, 1 } Parts each ſignifying { 2, 5, 10 } *Centeſms.*

The Line of *Sines* is numbred unequally to 90°. 00'. thus:

From { 1, 10, 20, 30 } to { 10, 20, 30, 50 } Every *Degree* is divided into { 12, 6, 4, 2 } Parts each ſignifying { 5, 10, 15, 30 } *Minutes.*

From { 50, 70, 80 } to { 70, 80, 90 } Every *Diviſion* is { 1, 2, 5 } *Degrees.*

The Line of *Tangents* is numbred unequally to 45°. 00'. and back again to 90°. 00'. thus:

From { 1, 10, 20 } to { 10, 20, 45 } Every *Degree* is ſub-divided into { 12, 6, 4 } Parts each denoting { 5, 10, 15 } *Minutes.*

And for the advantage of ſome *Problems in Aſtronomy*, the *Tangents* are continued forward from 45°. 00' to 60°. 00'.

§. 3. *Numeration on the Line of Numbers.*

Find the *Firſt Figure* among the *Primes*, for the *Second* count ſo many *Tenths* forward from thence as the ſaid Figure amounts to; for the *Third* count from the *Tenth* ſo many *Centeſms* as that *Figure* hath *Units*, and if there be *Four Figures*, then eſtimate it by ſuppoſing the following *Centeſm* to be ſubdivided into 10 parts.

Example.

Example. *To find the Point repreſenting* 1728.

Find 1 the *Firſt Figure* among the *Primes* at the beginning of the Line C, for 7 the *Second Figure* count 7 *Tenths* forward, for 2 the *Third Figure* count 2 *Centeſms* from the *Tenths*, and for 8 the *Fourth Figure* make as near an eſtimation as you can.

Hence will follow theſe Corollories.

1. That on a Line of this length the *three Firſt Figures* only of any Number can be exactly diſcovered, yet this uncertainty cauſes no great inconvenience in the uſe of the *Rule*.

2. The Figures by which the *Primes* are diſtinguiſhed in relation to one and the ſame Number, always retain the *ſame Value*.

As on the Line C when the Firſt 1 ſtands for,

1	*Then the*	2, 3, 4, 5, &c.	*Units.*
10	2. 3. 4. 5, &c.	20, 30, 40, 50, &c.	
100	*ſtand for*	200, 300, 400, 500, &c.	

The *Tenths*	*Tenths*	The *Cen-*	*Hundreths,*
in theſe	*Units*	*teſms* in	*Tenths,*
Primes are	10 *Units*	theſe *Tenths*	*Units.*

For Decimal Fractions: When 10 at the end ſtands for an *Unit*, then the Figures 9, 8, 7, 6, &c. are *Tenths*, the *Tenths* in theſe *Primes* are *Hundreths*, and the *Centeſms* in theſe *Tenths*, *Thouſands*; always decreaſing in a *Decuple Proportion*.

3. *Single Numbers* as 1, 2, 3, 4, &c. and thoſe which after the firſt Figure have only *Cyphers* as 10, 20, 30; 100, 200, 300; 1000, 2000, 3000, &c. are all repreſented at the *ſame Point*.

4. When the given Number conſiſts of *Three Places*, and hath *One Cypher* in the *Middle*, find it between the beginning of the *Prime* unto which it belongs, and the *Firſt Tenth* of the *ſame Prime*.

5. When

5. When the given Number consists of *Four Places*, and hath *two Cyphers* in the *Middle*, find it between the beginning of the *Prime* unto which it belongs, and the *First Centesm* of the *same Prime*.

6. When the *Line of Numbers* is repeated, the *Second* is in Value a *Degree* more than the *First*, and the *Third* a *Degree* more than the *Second*.

As on the Line D, when the First 1 stands for	then 1 in the *Middle* is	And 10 at the end is
.01	.1	1
.1	1	10
1	10	100
10	100	1000

Units.

CHAP. II.

Use of the Rule in Arithmetick.

ARithmetick is the Art of Numbring well, for as Magnitude is the Subject of Geometry, so is Multitude that of Arithmetick.

SECT. I.

§. 1. *Of Multiplication.*

MUltiplication teaches how by any two Numbers to find a Third, which shall contain either of the given Numbers so many times as the other contains Unity.

PROB.

PROB. I.

Given one Number to be multiplied by another: } *To find the Product.*

EXample. *What is the Product of* 30 *Multiplied by* 25?

As 1 on either Radius, or 10 at the end on B,
is to 30, one of the Factors, on A;
So is 25, the other Factor, on B,
to 750, the *Product*, on A.

And the Places in the *Product* muſt be equal to thoſe in both the *Factors*: But when the two Firſt Figures of the *Product* exceed thoſe of the *leſſer Factor*, then it will have *one Place leſs*.

And the *Firſt* and *Third Terms* muſt be always counted on the ſame Line, (which you will whether A or B) and the *Second* and *Fourth* on the other.

§. 2. *Of Diviſion.*

Diviſion teaches how to divide any Number into as many equal parts as you pleaſe.

PROB. II.

Given one Number to be divided by another: } *To find the Quotient.*

EExample. *What is the Quotient of* 750 *divided by* 25?

As 25, the Diviſor, on B,
is to 1 on A;
So is 750, the Dividend, on B,
to 30, the *Quotient*, on A.

And

And the *Places* in the *Quotient* muſt be equal to the *Exceſs* of the *Dividend* above the *Diviſor*; But when the *two firſt Figures* of the *Dividend* exceed thoſe of the *Diviſor* then it wll have *one place more.*

Given any Diviſor. To find a Factor equal thereto, & contra.

As 25 a Diviſor on B,
is to 1 on A;
So is 1 on B,
to .04, a *Factor*, on A.

§. 3. *Of Reduction of Fractions.*

PROB. III.

Given a Vulgar Fraction: } *To find a Decimal equal thereto.*

EXample. *Let* $\frac{63}{84}$ *be given to be reduced.*

As 84, the Denominator, on B,
is to 63, the Numerator, on A;
So is 1 on B,
to .75, the *Decimal*, on A.

PROB. IV.

Given a Decimal Fraction: } *To Reduce it into the known parts of the Integer.*

1. EXample. *Let .7625 be the Decimal of a Pound to be reduced into Shillings, Pence, or Farthings.*

As

As 10 at the end on B,
is to 20, the Shillings in a Pound, on A;
So is .7625, the given Decimal, on B,
to 15.25, the *Shillings*, on A, that is, 15 *s.* 3 *d.*

And if, instead of 20, you use 240, the *Pence* in a *Pound*, or 960, the *Farthings* in a *Pound*, you shall have the number of *Pence*, or *Farthings*.

2. Example. *Let .7625 be the Decimal of an Ale Barrel.*

As 10 at the end on B,
is to 32, the *Gallons* in an *Ale Barrel*, on A;
So is .7625 the given Decimal, on B,
to 24.4, the *Gallons*, on A.

SECT. II.

Use of the Instrument in the Rule of Three.

THE Rule of Three teaches how by three Numbers known, to find a Fourth unknown, and is either Direct, or Inverse.

PROB. V.

Given three Numbers: } *To find a fourth Proportional.*

1. *If the Proportion be Direct.*

EXample. *If 6 Quarters of Malt will make 18 Barrels of Beer.* } *How many Barrels of such Beer will 30 Quarters make?*

As

As 6, the First Term, on B,
is to 18, the Second, on A;
So is 30, the Third Term, on B,
to 90, the *Fourth*, on A.

2. *If the Proportion be Inverse.*

Example. *If 6 Pioneers can Dig a Trench in 10 Days, in how many Days can 12 do the same?*

As 12, the Third Term, on B,
is to 10, the Second, on A;
So is 6, the First Term, on B,
to 5, the *Fourth*, on A.

Note, The *First* and *Third Terms* must always be of the *same Denomination.*

And if	require	The proportion is
more / more	more, or less, / less, or less,	less / more	Direct / Inverse

PROB. VI.

Given two Numbers: *To find a Third, Fourth, Fifth, Geometrically Proportional.*

EXample. *Let 2 and 4 be the given Numbers.*

As 2, the lesser Extreme, on B,
is to 4, the greater, on A;
So is 4, the greater Extreme, on B,
to 8, the *Third Proportional*, on A.
And so is 8, the Third Proportional, on B,
to 16, the *Fourth*, on A;
And so is 16, the Fourth Proportional, on B,
to 32, the *Fifth*, on A.

And

And if you proceed forward you will find that 64 the *Sixth Proportional* on B, will fall off the Line A, therefore find 64 in the *First Radius* on B, and againſt it on A is 128 the *Seventh Proportional.*

Or as 4, the greater Extreme, on B,
is to 2, the leſſer, on A;
So is 2, the leſſer Extreme, on B,
to 1, the *Third Proportional*, on A.
And ſo is 1, the Third, on B,
to .5, the *Fourth Proportional*, on A;
And ſo is .5, the Fourth, on B,
to .25, the *Fifth Proportional*, on A, and ſo on.

PROB. VII.

Given Three Numbers: } *To find a Fourth in a Duplicate Proportion.*

1. Example. *Given a Circle whoſe* { *Diamet.* 1. / *Area* 0.7854 } *To find the Area of a Circle whoſe Diam. is* 30 *Inch.* (Inch)

As 1, one of the Diameters, on C,
is to .7854, its Area, on D;
So is 30, the other Diameter, on C,
to 706.8, its *Area*, on D.

For all like Plains are in Proportion one to another as the Squares of their like Sides.

2. Example. *If a Square whoſe Side is* 50 *Feet, require* 3000 *Tiles to Pave it.* } *How many ſuch Tiles will Pave a Square whoſe Side is* 30 *Feet?*

As

As 50, one of the Sides, on C,
is to 3000, its Number of Tiles, on D;
So is 30, the other Side, on C,
to 1080, its *Number of Tiles*, on D.

The Converse.

As 3000, one Number of Tiles, on D,
is to 50, its Side, on C;
So is 1080, the other Number of Tiles, on D,
to 30, its *Side*, on C.

PROB. VIII.

Given any Number under 10000: } *To find the Square-root.*

To extract the Square-root, is to find such a Number which Multiplied into its self will produce the given Number.

If the Lines C and D be applied one to another, so as 10 at the end of C, be even with 10 at the end of D, then against any Number on D is the *Square-root* on C, *& Contra.*

If the numb. consists of { 1,3,5,7 / 2,4,6,8 } *Integers*, find it in the { *First* / *Second* } *Radius* of D, and against it on C, is the *Square-root.*

Which must consist of as many *Places* as there are *Periods* in the *Arithmetical Extraction.*

Thus against { 361 / 16 } in the { *First* / *Sec.* } *Radius* of D is { 19 / 4 } on C, the *Square-root.*

PROB.

PROB. IX.

Given any two Numbers: } *To find a Geometrical Mean between them.*

EXample. *Let* 8 *and* 32 *be the given Numbers.*

As 8, in the Second Radius, on D,
is to 8 on C;
So is 32, in the First Radius, on D,
to 16 the *Mean* on C.

For as 8.16 :: 16.32 And 8 × 32 = 16 × 16 = 256.

But if the Places of the given Numbers are equal, then find them both in the same Radius.

PROB. X.

Given any two Numbers: } *To find two Geometrical Means between them.*

EXample. *Let* 6 *and* 48 *be the given Numbers.*

1. As 6, the lesser Extreme, on B,
is to 1 on A;
So is 48, the greater Extreme, on B,
to 8 on A.

Which find on E, and against it on C is 2 the *Cube-root.*

2. As 1 on B,
is to 2, the Cube-root, on A;
So is 6, the lesser Extreme, on B,
to 12, the *First Mean*, on A.

3. As

3. As 1 on B,
is to 12, the *First Mean*, on A;
So is 2, the Cube-root, on B,
to 24, the *Second Mean*, on A.

PROB. XI.

Given any two Numbers: } *To find three Geometrical Means between them.*

EXample. *Let* 4 *and* 64 *be the given Numbers.*

1. As 1 on B,
is to 64, the Cube of the leſſer Extreme, on A,
So is 64, the greater Extreme, on B,
to 4096 on A:
Whoſe *Biquadrate-root* is 8. the *First Mean.*
2. As 4, the leſſer Extreme, on B,
is to 8, the First Mean, on A;
So is 8, the First Mean, on B,
to 16, the *Second Mean*, on A;
3. As 4, the leſſer Extreme, on B,
is to 16, the *Second Mean*, on A;
So is 16, the Second Mean, on B,
to 32, the *Third Mean*, on A.

PROB. XII.

Given three Numbers: } *To find a Fourth in a Triplicate Proportion.*

1. EXample. *Given a Cube whoſe* { *Side* ... 12 / *Content* 1728 } *To find the Cont. of a Cube whoſe Side is* 15.12 *Inches?*

As

As 12, one of the Sides, on C,
is to 1728, its Solid Content, on E;
So is 15.12, the other Side, on C,
to 3456, its *Solid Content*, on E.

For all like Solids are in Proportion one to another as the Cubes of their like Sides.

The Converſe.

As 1728, one Content, on E,
is to 12, its Side, on C;
So is 3456, the other Content, on E,
to 15.12, its *Side*, on C.

2. Exam. Given a Sphere whoſe { *Axis* 4 *Inches*; *Weight* 9 *Pound* } To find the *Weight* of a Sphere whoſe *Axis is* 8 *Inches*?

As 4, one of the Axis, on C,
is to 9, its Weight, on E;
So is 8, the other Axis, on C,
to 72, its *Weight*, on E.

The Converſe.

As 9, the Weight of one Sphere, on E,
is to 4, its Axis, on C;
So is 72, the Weight of the other Sphere, on E,
to 8, its *Axis*, on C.

3. Examp. Given an Iron Sphere whoſe { *Axis* 4 *Inches*; *Weight* 9 *Pounds* } To find the *Axis* of a Leaden Sphere of the ſame Weight?

As

As .925, the Tabular number for Iron, on E,
is to 4, its Axis, on C;
So is .6435, the Tabular number for Lead, on E,
to 3.54, its *Axis*, on C.

Proportion of these Metals one to another, if the Shape, and Weight be the same.

♃	*Tin*	1.0000	1.000	♄	*Lead*	0.6435	1.554
♂	*Iron*	0.9250	1.081	☿	*Quick-silver*	0.5433	1.841
♀	*Copper*	0.8222	1.216				
☽	*Silver*	0.7161	1.396	☉	*Gold*	0.3895	2.567

4. Exam. Given an Iron Sphere whose *Weight is* 60 *Pounds*, *Axis* 7.57 *Inches*. To find the *Ax.* of a Leaden Sphere whose *Weight is* 80?

By *Example* 3. The Axis of a Leaden Sphere of the same Weight is 6.7 Inches, then say:

As 60, the Content of one Sphere, on E,
is to 6.7, its Axis on C;
So is 80, the Content of the other Sphere, on E,
to 7.4, its *Axis*, on C.

5. Examp. Given a Golden Cube whose *Side* 2 *Inches*, *Weight* 240 *Ounces*. To find the *Side* of a *Tin* Cube of the same *Weight*?

As .3895, the Tab. number for Gold, on E,
is to 2, its Side, on C;
So is 1.0000, the Tab. number for Tin, on E,
to 2.74, its *Side*, on C.

PROB.

PORB. XIII.

Given any Number under 1000000 : } *To find the Cube-root.*

TO extract the Cube-root is to find such a Number which Multiplied into its self, and that Product by the Root produces the given Number.

If the Lines C and E be applied one to another, so as 10 at the end of C be even with 1000 at the end of E, then againſt any Number on E is the Cube-root on C, *& Contra.*

If the Number conſiſts of { 1.4.7 / 2.5.8 / 3.6.9 } *Integers*, find it in the { *First* / *Second* / *Third* } *Radius* of E, and againſt it on C is the *Cube-root.*

Which muſt conſiſt of as many *Places*, as there are *Periods* in the *Arithmetical Extraction.*

Thus againſt { 3375 / 35.95 / 125, } In the { *First* / *Second* / *Third* } *Radius* on E is { 15 / 3.3 / 5 } On C the *Cube root.*

SECT.

SECT. III.

Uſe of the Rule in Fellowſhip.

FEllowſkip *is either double or ſingle* (*that is*) *either with, or without Time.*

§. 1. *Of Fellowſhip without Time.*

Fellowſhip without Time ſhews how by the reſpective Stocks, with the whole Gain or Loſs; To find each particular Perſons Gain or Loſs, without any conſideration of Time.

PROB. XIV.

Five Merchants C. D. E. F. *and* G *make a Company,* C *put into Stock* 84 *l.* D 72 *l.* E 48 *l.* F 54 *l. and* G 42 *l.* *By which they gain* 50 *l. what is each Man's ſhare of the Gain?*

THE reſolution hereof by the Cuſtomary *Method* (there being Five Numbers ſought) requires *five Proportions*, but all done at once ſetting the *Rule*, thus:

As 300, the *whole Stock*, on B, is to 50, the *whole Gain*, on A, ſo is	84 C	*Stock* on B to	14 C	*Gain* on A.
	72 D		12 D	
	48 E		8 E	
	54 F		9 F	
	42 G		7 G	

PROB.

PROB. XV.

Three Merchants C D *and* E *enter into Partnerſhip,* C *put in* 35 *l. more than* D, *and* D *and* E *together put in* 84 *l. the Gain is* 66 *l. of which* E's *Share is* 21 *l.*

To find what Stock each put in, and what are C *and* D's *Shares?*

1. As 1 on B.
is to 35, the Exceſs of C's Stock above D's, on A;
So is 66, the whole Gain, on B,
to 2310 on A.
2. As 1 on B,
is to 84, D and E's Stock, on A;
So is 66, the whole Gain, on B,
to 5544 on A.
3. As 1 on B,
is to 84, D's and E's Stock, on A;
So is 21, E's Share of the Gain, on B,
to 1764 on A.

And 1764 taken from 7854 (the Sum of the two firſt Products) leaves 6090 which reſerve.

4. As 87, the Sum of the whole Gain and E's Share on B,
is to 1 on A;
So is 6090, the reſerved Remainder, on B,
to 70, *C's Stock*, on A.

Therefore D's Stock is 35, and E's 49, according to the tenour of the *Queſtion*.

§. 2. Of Fellowship with Time.

Fellowship with Time is when divers Partners make a joynt Stock, and each draweth out, or puteth into it, when and what he pleaseth according as his Occasions require.

PROB. XVI.

Two Merchants C *and* D *make a Company, by which they Gain* 50 *l.* *To find each Man's Share?*

C	*Laid in*	100 *l.*	*For*	4	*Months*	
D		136 *l.*		3		

1. As 1 on B, is to	4	on A, so is	100	on B, to	400 C'	Stock on A.
	3		136		408 D'	

2. As 808 on B, is to 50 on A, so is	400 C'	*Stock* on B, to	24.75 C'	*Gain* on A.
	408 D'		25.25 D'	

PROB.

PROB. XVII.

Two Merchants C *and* D *enter into Company, and lay in a Stock of* 277 *l. the Gain is* 199 *l. which they equally share.*

C *laid in his Part for* 7 *Months*
D *for* 9

To find what distinct Stock each put in?

As 16, the whole Time their Stocks were in Company, on B,
is to 277, the whole Stock, on A;
So is 9, the Time D's Stock was in Company, on B,
to 155.81, C's *Stock*, on A.
And so is 7, the Time C's Stock was in Company, on B,
to 121.19, *D's Stock*, on A.

SECT. IV.

Use of the Rule in Alligation.

Alligation is either Medial, or Alternate.

§. 1. *Of Alligation Medial.*

Alligation Medial teaches how by the Quantities, and Prices of several Simples to be mixed, to find the Price of any part of such Mixture.

PROB. XVIII.

A Chandler mixeth together

10	Oats at 16 s.	160 s.		*To find how much one Quarter of this Mixture is worth?*
20	Barley at 24 s.	480 s.	*per Quarter*	
14	Beans at 20 s.	280 s.		

Quarters of

AS 44, the Sum of the given Simples, on B, is to 920, the whole Value, on A; So is 1, the Quantity whose Price is sought, on B, to 20.91 on A, that is, 20 *s.* 11 *d. ferè.*

§. 2. *Of Alligation Alternate.*

Alligation Alternate teaches how by the Prices of several Simples, to find what Quantity of each, to mix together, so that the whole Mixture may bear a given Price.

PROB. XIX.

A Grocer hath four sorts of Sugar, viz. *of* 12 *d. per l. of* 10 *d. per l. of* 6 *d. per l. and of* 4 *d. per l. of which he would make a Mixture of* 237 *l. worth* 9 *d. per l.* } *To find how much he must use of each?*

I Shall here for brevity sake omit the several ways of Linking or Coupling the Rates of the given Simples,

Simples, and refer you to Sir *Jonas Moor*, Mr. *Kersey*, and other Authors that Treat largely on Alligation, and only shew the speedy performance thereof by the *Rule*.

The *Prices* being here disposed of, and *Linked* as in the *Margin*, the Sum of the several *Differences* from the *Mean Price* is 12.

Sum 12

As 12, the Sum of the Differences, on B, is to 237 (the whole Mixture) on A, So is

5 *First*
3 *Second*
1 *Third*
3 *Fourth*

Difference on B, to

98.75
59.25
19.75
59.25

The Quantity of each Sort to be mixed, on A.

The same Method will hold in all the various ways of Linking the given Prices, whereby the Quantities sought are as often altered as the Question admits of various Alligations, and yet all true, and the Mixture thereby found will bear the given Price.

CHAP. III.

Use of the Rule in Military Orders.

A *Battle* is considered either in respect of the *number of Men*, or *Form* of the *Ground*: In respect of the
- Number of *Men* it is either a
  - *Square Battle.*
  - *Double Battle.*
  - *Battle of the Grand Front.*
  - *Battle of Proportion.*
- *Form* of the *Ground* it is a
  - *Square.*
  - *Oblong.*

And is distinguished into *two Orders, viz.*
- *Open*
- *Close*

which is
- 3
- 1.5

Feet distance both in *Rank* and *File.*

PROB. I.

Given any number of Soldiers.

To Order them into a Square Battle of Men (that is) as many in Rank as in File; and to find how many Square Feet of Ground they will take up at Open Order?

EXample. *Let* 2704 *be the number of Soldiers.* Against 2704 on D is 52 on C, the Depth in *Rank* and *File*, then:

As

As 1 on B,
is to 3, their Order, on A;
So is 52, the Depth in Rank and File, on B,
to 156 on A.

Which find on C, and against it on D is 24336 the *Square Feet of Ground.*

Here the number of Men in Rank and File are always equal, though the Ground they ſtand on be not an *exact Square.*

PROB. II.

Given any number of Soldiers. — *To Order them into a Double Battle of Men (that is) twice as many in Rank as in File; and to find how many Square Feet of Ground they will take up at Cloſe Order?*

Example. *Let* 2600 *be the numbers of Soldiers.*

1. Againſt 1300, half the number of Soldiers, on D is 36, *&c.* on C the Depth in File, which doubled is the Depth in Rank,

2. As 1 on B,
is to 1.5, their Order, on A;
So is 36, the Depth in File, on B,
to 54, the *Breadth of the Ground*, on A.
And ſo is 72, the Depth in Rank, on B,
to 1080, the *Length of the Ground*, on A.

3. As 1 on B,
is to 54, the Breadth of the Ground, on A;
So is 1080, the Length of the Ground, on B,
to 58320, the *Square Feet of Ground*, on A.

PROB. III.

Given any number of Soldiers: { *To Order them into a Battle of the grand Front (that is) four times as many in Rank as in File.*

EXample. *Let* 2048 *be the number of Soldiers.*
Against 512, a Quarter of the number of Men, on D, is 22, &c. on C the *Depth in File*, and 4 times 22 is 88 the *Depth in Rank*.
And by *Prob.* II. you may find how many *Square Feet of Ground* they will take up at *any Order*.

PROB. IV.

Given any number of Soldiers to be ordered into three Square Battles according to the Proportion of 5.7 *and* 10: { *To find how many must be in each Front?*

EXample. *Let* 6000 *be the number of Soldiers.*

As 22, the *Sum* of the *Terms*, of the *given Proportions* on B, is to { 6000 the number of Men on A, So is { 5 / 7 / 10 } the *Terms* of the *Proportion* on B, to { 1363.63 / 1910.10 / 2727.27 } on A.

Whose

Whose respective *Square-roots* are { 36, 43, 52 } and their *Squares* { 1296, 1849, 2704 }

Sum — 5849

Number of Men to stand aside — 151

Which may be employed as *Scouts*, *Centinels*, or other ways, for *Fractions* in *Military Orders* are always neglected.

PROB. V.

Given any number of Soldiers, and their Distance in Rank and File: { *To Order them into a Square Battle of Ground.*

EXample. *Let the number of Soldiers be* 2400 *their Distance in File* 7 *Feet, and in Rank* 3 *Feet,*

1. As 7, their Distance in File, on B,
   is to 3, their Distance in Rank, on A;
   So is 2400, the number of Soldiers, on B,
   to 1029. a *fourth Number*, on A.

Which find on D, and against it on C is 32 &c. the *Depth in File.*

2. As 32, the Depth in File, on B,
   is to 1 on A.
   So is 2400, the number of Soldiers, on B.
   to 75, *the Depth in Rank*, on A.

Here though the number of Men in Rank and File are not equal, yet the Ground they stand on must always be a *perfect Square.*

PROB. VI.

Given any number of Soldiers, and the Distance in Rank and File: } *To place them in Rank and File according to any given Proportion.*

EXample. *Let the number of Soldiers be* 3000, *their Distance in File* 7 *Feet, and in Rank* 4 *Feet, and let the Length of the Ground for the Rank be in Proportion to the Length of the Ground for the File, as* 9 *to* 5.

1. As 1 on B,
   is to 63, the Rectangle of 7 and 9 the Distance in File, and Proportional number for the Rank, on A;
   So is 3000, the number of men, on B,
   to 189000, *a fourth Number*, on A.

2. As 20, the Rectangle of 4 and 5 the Distance in Rank, and Proportional number for the File, on B,
   is to 1 on A;
   So is 189000, the fourth Number, on B,
   to 9450 on A.

Which find on D, and against it on C is 97, &c. the *Depth in Rank.*

3. As 97, the Depth in Rank, on B,
   is to 1 on A;
   So is 3000, the number of Men, on B,
   to 30, the *Depth in File*, on A.

PROB.

PROB. VII.

Given a Square Battle of 8100 Soldiers to be environed by 6 Ranks of Pikes: { *To find how many Ranks must be in the whole Square Battle, and how many Pikes and Musketeers?*

FInd 8100 on D, and against it on C is 90, the number of Men in *Rank and File*: Now seeing there must be 6 *Ranks of Pikes* about the *Musketeers*, there will be 12 *Ranks* less of them both in Front and Flank than in the whole Body; therefore Substract 12 from 90 and the Remainder is 78 which find on C, and against it on D is 6084 the number of *Musketeers*, which taken from 8100 the whole Body, there remains 2016 the number of *Pikes*.

PROB. VIII.

Given a Square Battle of Soldiers in which are 256 Musketeers enclosed by 320 Pikes: { *To find how many Deep the Pikes must be to continue the perfect Square?*

1. FInd 576 the *whole Battle* on D, and against it on C is 24 the Side.
2. Find 256 the number of *Musketeers* on D, and against it on C is 16 the Side.

Which taken from 24 the Side of the *whole Battle* rest 8, whose half is 4 the number of *Pikes in Depth*.

PROB.

PROB. IX.

Given a Square whose Side is 300 *Feet, in which may be Lodged* 1000 *Soldiers:* } *To find the Side of a Square, in which may be Lodged* 5000?

As 1000, the first number of Soldiers, on D,
is to 300, its Side, on C;
So is 5000, the other number of Soldiers, on D,
to 671, its *Side*, on C.

CHAP. IV.

Use of the Rule in Interest.

Interest is either Simple or Compound.

§. 1. *Of Simple Interest.*

Simple Interest is the Increase which arises from the Principal only, and is grounded on a Rank of Numbers Arithmetically Proportional.

PROB.

PROB. I.

Given the Principal, Time, and Rate: { *To find the Amount.*

EXample. *What will* 15.5 l. *Amount to in* 12 *Years at* 6 *l.* per Cent. per Ann.?

1. As 1 on B,
is to .06, the Rate of Interest, on A;
So is 12, the given Years, on B,
to .72, the *Interest of* 1 l. *in that Time*, on A.
2. As 1 on B,
is to 1.72, the Amount of 1 *l.* in 12 years, on A;
So is 15.5, the Principle, on B,
to 26.66, the *Amount*, on A.

PROB. II.

Given the Amount, Rate, and Time: { *To find the Principal.*

EXample. *What is* 26.66 *l. due* 12 *Years hence worth in ready Mony at* 6 *l.* per Cent. per Ann.?

By *Prob.* 1. the Amount of 1 *l.* in 12 Years is 1.72, then say:

As 1.72, the Amount of 1 *l.* in that Time, on B,
is to 1 on A;
So is 26.66, the given Amount, on B,
to 15.5, the *Principal*, on A.

PROB.

PROB. III.

Given the Principal, Amount, and Rate: } *To find the Time.*

EXample. *In how many Years will* 15.5 *l. Amount to* 26.66 *l. at* 6 *l.* per Cent. per Ann.?

1. As 15.5, the Principal, on B,
   is to 1 on A;
   So is 11.66, the Intereſt, on B,
   to .72, the Intereſt of 1 *l.* in 12 years, on A.
2. As .06, the Rate of Intereſt, on B,
   is to 1 on A;
   So is .72, the Intereſt of 1 *l.* in that Time, on B,
   to 12, the *Time*, on A.

Note, the *Amount* leſs the *Principal* is the *Intereſt*.

PROB. IV.

Given the Principal, Amount, and Time: } *To find the Rate.*

EXample. *At what Rate of Intereſt will* 15.5 *l. Amount to* 26.66 *l. in* 12 *Years?*

As 186, the Fact of the Principal and Time, on B,
is to 1 on A;
So is 1116, the Intereſt multiplied by 100, on B,
to 6, the Rate, on A.

PROB.

PROB. V.

Given an Annuity, Time, and Rate: { *To find the Amount.*

EXample. *What will an Annuity of 62 l. Amount to in 4 Years at 6 l.* per Cent. per Ann.?

1. As 1 on B,
   is to .06, the Rate of Intereſt, on A;
   So is 62, the given Annuity, on B,
   to 3.72, its *Intereſt in one Year*, on A:
2. As 1 on B,
   is to 3.72, Intereſt of 62 *l.* in one Year, on A;
   So is 2, half the given Time, on B,
   to 7.44, *the Intereſt of the Annuity for half the Time*, on A.
3. As 1 on B,
   is to 7.44, the Intereſt of the Annuity for half the Time, on A.
   So is 3, the given Years leſs 1, on B,
   to 22.32, the Intereſt of the Annuity, on A.

To which add 248, the four *Annual* Payments, the Sum is 270.32 the *Amount*.

PROB. VI.

Given the Amount, Time, and Rate: { *To find the Preſent Worth.*

EXample. *What is the Preſent Worth of an Annuity whoſe Amount is 270.32 l. to continue 4 Years at 6 l.* per Cent. per Ann.?

By Prob. I. the Amount of 1 *l.* in 4 Years is 1.24 then ſay:

As 1.24, the Amount of 1 *l.* in 4 Years, on B,
is to 1 on A;
So is 270.32, the given Amount, on B,
to 218, the *preſent Worth*, on A.

But becauſe all *preſent Worths* either of *Principal Sums*, or *Annuities* due at any Time to come, ought to be conſidered in a *Geometrical Proportion* according to the ſeveral *Rates of Compound Intereſt*, therefore all Calculations of *Annuities* at *Simple Intereſt* ought to be rejected as erroneous and uſeleſs.

Note, If you Multiply .002739726 (the *Decimal* for one *Day*) by .06, .07, 08, *&c. per Cent.* the *Product* will be the *Intereſt* of 1 *l.* for a *Day*.

§. 2. *Of Compound Intereſt.*

Compound Intereſt is the Increaſe which ariſes from the Principal and Intereſt, and is grounded on a Rank of Numbers Geometrically Proportional, For:

As 1 on B,
is to its Amount in one Year, on A;
So is the Amount in one Year, on B,
to the Amount in *two Years*, on A.
And ſo is that in *two Years*, on B.
to that in *three Years*, on A and ſo on, Then:
As 1 on B,
is to the Amount of 1 *l.* in any given Time, on A;
So is any given Sum, on B,
to its *Amount* in the *ſame Time*, on A.

PROB.

PROB. I.

Given the Principal, Time, and Rate: { *To find the Amount.*

EXample. *What will* 15.5 *l. Amount to in* 12 *Years at* 6 *l.* per Cent. per Ann.?

As 1 on B,
is to 2.0122, the Tabular Amount of 1 *l.* in 12 Years, on A;
So is 15.5, the Principal, on B,
to 31.189, the *Amount*, on A.

But if the *Interval* between any two *Payments* be less than a *Year*, consider what Part it is whether { 3/4, 1/2, 1/4, 1/12, 1/52, 1/365 } or { 273.75, 182.5, 91.25, 30.416, 7., 1. } *Days*, or any other odd number of *Days* that falls between such even parts of the *Year*.

Example. *What will* 42 *l. Amount to in* 104 *Days at* 6 *l.* per Cent. per Ann.?

As 1 on B,
is to 1.0167, the Tabular Amount of 1 *l.* in 104 Days, on A;
So is 42, the Principal, on B,
to 42.703, the *Amount*, on A.

Amount

Amount of 1 *l.* Sterling *at* 6 *l.* per Cent, per An. *Compound Interest.*

Yea.	0	¼	½	¾
0	1.00000	1.01467	1.02956	1.04467
1	1.06000	1.07555	1.09134	1.10735
2	1.12360	1.14009	1.15682	1.17379
3	1.19102	1.20849	1.22623	1.24422
4	1.26248	1.28100	1.29980	1.31887
5	1.33822	1.35786	1.37779	1.39800
6	1.41852	1.43933	1.46045	1.48188
7	1.50363	1.52569	1.54808	1.57080
8	1.59385	1.61724	1.64097	1.66505
9	1.68948	1.71427	1.73942	1.76495
10	1.79085	1.81713	1.84379	1.87085
11	1.89830	1.92615	1.95442	1.98310
12	2.01220	2.04172	2.07168	2.10208
13	2.13293	2.16423	2.19598	2.22821
14	2.26090	2.29408	2.32774	2.36190
15	2.39656	2.43172	2.46741	2.50361
16	2.54023	2.57763	2.61545	2.65383
17	2.69277	2.73229	2.77238	2.81306
18	2.85434	2.89622	2.93872	2.98184
19	3.02560	3.07000	3.11504	3.16075
20	3.20713	3.25420	3.30195	3.35040
21	3.39956	3.44945	3.50006	3.55142
22	3.60354	3.65641	3.71007	3.76451
23	3.81975	3.87580	3.93267	3.99038
24	4.04893	4.10835	4.16863	4.22980
25	4.29187	4.35489	4.41875	4.48359
26	4.54938	4.61614	4.68388	4.75261
27	4.82235	4.89311	4.96491	5.03776
28	5.11169	5.18669	5.26280	5.34003
29	5.41839	5.49790	5.57857	5.66043
30	5.74349	5.82777	5.91328	6.00005
31	6.08810			

Days	Decimals of Days for simple Interest.	Amount of 1l. at 6l. per Cent. Comp. Int.	Days	Decimals of Days for simple Interest.	Amount of 1l. at 6l. per Cent. Comp. Int.
1	.0027397	1.000160	31	.0849315	1.004961
2	.0054795	1.000319	32	.0876712	1.005122
3	.0082192	1.000479	33	.0904110	1.005282
4	.0109589	1.000639	34	.0931507	1.005443
5	.0136986	1.000799	35	.0958904	1.005603
6	.0164384	1.000958	36	.0986301	1.005764
7	.0191781	1.001118	37	.1013699	1.005924
8	.0219178	1.001278	38	.1041096	1.006085
9	.0246575	1.001438	39	.1068493	1.006245
10	.0273973	1.001598	40	.1095890	1.006406
11	.0301370	1.001758	41	.1123288	1.006567
12	.0328767	1.001918	42	.1150685	1.006727
13	.0356164	1.002077	43	.1178082	1.006888
14	.0383562	1.002237	44	.1205479	1.007049
15	.0410959	1.002397	45	.1232877	1.007210
16	.0438356	1.002557	46	.1260274	1.007370
17	.0465753	1.002718	47	.1287671	1.007531
18	.0493151	1.002878	48	.1313068	1.007692
19	.0520548	1.003078	49	.1342466	1.007853
20	.0547945	1.003198	50	.1369863	1.008014
21	.0575342	1.003358	51	.1397260	1.008175
22	.0602740	1.003518	52	.1424657	1.008336
23	.0630137	1.003678	53	.1452055	1.008497
24	.0657534	1.003939	54	.1479452	1.008658
25	.0684932	1.003999	55	.1506849	1.008818
26	.0712329	1.004159	56	.1534247	1.008980
27	.0739726	1.004320	57	.1561644	1.009141
28	.0767123	1.004480	58	.1589041	1.009302
29	.0794520	1.004640	59	.1616438	1.009463
30	.0821918	1.004801	60	.1643836	1.009624

Days	Decimals of Days.	Amounts of 1 l.	Days	Decimals of Days	Amounts of 1 l.
61	.1671233	1.009786	91	.2493151	1.014633
62	.1698630	1.009947	92	.2520548	1.014795
63	.1726027	1.010108	93	.2547945	1.014957
64	.1753425	1.010269	94	.2575342	1.015119
65	.1780822	1.010431	95	.2602740	1.015281
66	.1808219	1.010592	96	.2630137	1.015443
67	.1835616	1.010753	97	.2657534	1.015606
68	.1863014	1.010915	98	.2684931	1.015768
69	.1890411	1.011076	99	.2712329	1.015930
70	.1917808	1.011237	100	.2739726	1.016093
71	.1945205	1.011398	101	.2767123	1.016254
72	.1972603	1.011560	102	.2794520	1.016417
73	.2000000	1.011722	103	.2821918	1.016579
74	.2027397	1.011883	104	.2849315	1.016741
75	.2054794	1.012045	105	.2876712	1.016903
76	.2082192	1.012207	106	.2904110	1.017066
77	.2109589	1.012368	107	.2931507	1.017228
78	.2136986	1.012530	108	.2958904	1.017397
79	.2164383	1.012691	109	.2986301	1.017553
80	.2191781	1.012853	110	.3013699	1.017715
81	.2219178	1.013015	111	.3041096	1.017878
82	.2246575	1.013177	112	.3068493	1.018046
83	.2273973	1.013338	113	.3095890	1.018203
84	.2301370	1.013500	114	.3123288	1.018366
85	.2328767	1.013662	115	.3150685	1.018528
86	.2356164	1.013824	116	.3178082	1.018691
87	.2383562	1.013986	117	.3205479	1.018853
88	.2410959	1.014147	118	.3232877	1.019016
89	.2438356	1.014309	119	.3260274	1.019179
90	.2465753	1.014471	120	.3287671	1.019346

Days	Decimals of Days.	Amounts of 1 l.	Days	Decimals of Days.	Amounts of 1 l.
121	.3315068	1.019504	151	.4136986	1.024399
122	.3342466	1.019667	152	.4164384	1.024562
123	.3369863	1.019830	153	.4191781	1.024726
124	.3397260	1.019992	154	.4219178	1.024989
125	.3424657	1.020155	155	.4256575	1.025054
126	.3452055	1.020318	156	.4273973	1.025217
127	.3479452	1.020481	157	.4301370	1.025380
128	.3506849	1.020644	158	.4328767	1.025544
129	.3534247	1.020807	159	.4356164	1.025708
130	.3561644	1.020970	160	.4383562	1.025871
131	.3589041	1.021133	161	.4410959	1.026035
132	.3616438	1.021296	162	.4438356	1.026199
133	.3643836	1.021461	163	.4465753	1.026363
134	.3671233	1.021622	164	.4493151	1.026527
135	.3698630	1.021785	165	.4520548	1.026691
136	.3726027	1.021948	166	.4547945	1.026855
137	.3753425	1.022112	167	.4575342	1.027018
138	.3780822	1.022275	168	.4602740	1.027182
139	.3808219	1.022438	169	.4630137	1.027346
140	.3835616	1.022601	170	.4657534	1.027510
141	.3863014	1.022765	171	.4684932	1.027675
142	.3890411	1.022928	172	.4712329	1.027839
143	.3917808	1.023091	173	.4739726	1.028003
144	.3945205	1.023254	174	.4767123	1.028167
145	.3972603	1.023418	175	.4794521	1.028331
146	.4000000	1.023581	176	.4821918	1.028495
147	.4027397	1.023745	177	.4849315	1.028659
148	.4054795	1.023908	178	.4876712	1.028824
149	.4082192	1.024072	179	.4904110	1.028988
150	.4109589	1.024235	180	.4931507	1.029152

Days	Decimals of Days.	Amounts of 1 l.	Days	Decimals of Days.	Amounts of 1 l.
181	.4958904	1.029316	211	.5780822	1.034258
182	.4986301	1.029481	212	.5808219	1.034423
183	.5013700	1.029645	213	.5835616	1.034588
184	.5041096	1.029810	214	.5863014	1.034753
185	.5068493	1.029974	215	.5890411	1.034919
186	.5095890	1.030138	216	.5917808	1.035084
187	.5123288	1.030803	217	.5945205	1.035249
188	.5150685	1.030467	218	.5972603	1.035414
189	.5178082	1.030632	219	.6000000	1.035580
190	.5205480	1.030796	220	.6027397	1.035745
191	.5232877	1.030961	221	.6054794	1.035910
192	.5260274	1.031126	222	.6082192	1.036076
193	.5287671	1.031290	223	.6109589	1.036241
194	.5315068	1.031455	224	.6136986	1.036407
195	.5342466	1.031619	225	.6164383	1.036572
196	.5369863	1.031784	226	.6191781	1.036737
197	.5397260	1.031949	227	.6219178	1.036903
198	.5424658	1.032137	228	.6246575	1.037069
199	.5452055	1.032278	229	.6273973	1.037234
200	.5479452	1.032443	230	.6301370	1.037400
201	.5506849	1.032608	231	.6328767	1.037565
202	.5534247	1.032773	232	.6356164	1.037731
203	.5561644	1.032938	233	.6383562	1.037897
204	.5589041	1.033103	234	.6410959	1.038062
205	5616438	1.033268	235	.6438356	1.038228
206	.5643836	1.033433	236	.6465753	1.038394
207	.5671233	1.033598	237	.6493151	1.038560
208	.5698630	1.033758	238	.6520548	1.038725
209	.5726027	1.033928	239	.6547945	1.038891
210	.5753425	1.034093	240	.6575342	1.039057

Days	Decimals of Days.	Amounts of 1 l.	Days	Decimals of Days.	Amounts of 1 l.
241	.6602740	1.039223	271	.7424657	1.044212
242	.6630137	1.039389	272	.7452055	1.044379
243	.6657534	1.039555	273	.7479452	1.044545
244	.6684931	1.039721	274	.7506849	1.044712
245	.6712329	1.039887	275	.7534246	1.044879
246	.6739726	1.040053	276	.7561644	1.045046
247	.6767123	1.040219	277	.7589041	1.045213
248	.6794520	1.040385	278	.7616438	1.045380
249	.6821918	1.040551	279	.7643836	1.045546
250	.6849315	1.040717	280	.7671233	1.045713
251	.6876712	1.040888	281	.7698630	1.045884
252	.6904109	1.041050	282	.7726027	1.046057
253	.6931507	1.041216	283	.7753425	1.046214
254	.6958904	1.041382	284	.7780822	1.046381
255	.6986301	1.041548	285	.7808219	1.046548
256	.7013699	1.041715	286	.7835616	1.046711
257	.7041096	1.041881	287	.7863014	1.046883
258	.7068493	1.042047	288	.7890411	1.047050
259	.7095890	1.042214	289	.7917808	1.047217
260	.7123288	1.042380	290	.7945205	1.047384
261	.7150685	1.042546	291	.7972603	1.047551
262	.7178082	1.042713	292	.8000000	1.047719
263	.7205479	1.042879	293	.8027397	1.047886
264	.7232877	1.043046	294	.8054794	1.048053
265	.7260274	1.043212	295	.8082192	1.048220
266	.7287671	1.043379	296	.8109589	1.048388
267	.7315068	1.043545	297	.8136986	1.048555
268	.7342466	1.043712	298	.8164383	1.048723
269	.7369863	1.043879	299	.8191781	1.048890
270	.7397260	1.044045	300	.8219178	1.049057

Days	Decimals of Days.	Amounts of 1 l.	Days	Decimals of Days.	Amounts of 1 l.
301	.8246575	1.049225	336	.9205479	1.055104
302	.8273973	1.049393	337	.9232877	1.055272
303	.8301370	1.049560	338	.9260274	1.055441
304	.8328767	1.049728	339	.9287671	1.055609
305	.8356164	1.049895	340	.9315068	1.055779
306	.8383562	1.050063	341	.9342466	1.055946
307	.8410959	1.050230	342	.9369863	1.056115
308	.8438356	1.050398	343	.9397260	1.056284
309	.8465753	1.050566	344	.9424657	1.056452
310	.8493151	1.050734	345	.9452055	1.056621
311	.8520548	1.050901	346	.9479452	1.056790
312	.8547945	1.051021	347	.9506849	1.056958
313	.8575342	1.051237	348	.9534246	1.057127
314	.8602740	1.051405	349	.9561644	1.057296
315	.8630137	1.051573	350	.9589041	1.057465
316	.8657534	1.051738	351	.9616438	1.057633
317	.8684931	1.051908	352	.9643836	1.057802
318	.8712329	1.052076	353	.9671233	1.057971
319	.8739726	1.052244	354	.9698630	1.058140
320	.8767123	1.052412	355	.9726027	1.058309
321	.8794520	1.052580	356	.9753425	1.058478
322	.8821918	1.052748	357	.9780822	1.058647
323	.8849315	1.052916	358	.9808219	1.058816
324	.8876712	1.053084	359	.9835616	1.058985
325	.8904109	1.053253	360	.9863014	1.059154
326	.8931507	1.053421	361	.9890411	1.059323
327	.8958904	1.053589	362	.9917808	1.059492
328	.8986301	1.053757	363	.9945205	1.059662
329	.9013699	1.053925	364	.9972603	1.059838
330	.9041096	1.054094	365	1.0000000	1.060000
331	.9068493	1.054262			
332	.9095890	1.054430			
333	.9123288	1.054599			
334	.9150685	1.054767			
335	.9178082	1.054935			

PROB. II.

Given the Amount, Time, and Rate: } *To find the Principal.*

EXample. *What is* 31.189 *l. due* 12 *Years hence worth in ready Money at* 6 *l.* per Cent. per Ann?

As 2.0122, the Tabular Amount of 1 *l.* in 12 Years on B,
is to 1 on A;
So is 31.189, the given Amount, on B,
to 15.5, the *preſent Worth*, on A.

PROB. III.

Given the Principal, Amount, and Rate: } *To find the Time.*

EXample. *In what Time will* 15.5 *l. Amount to* 31.189 *l. at* 6 *l.* per Cent. per Ann?

As 15.5, the Principal, on B,
is to 1 on A;
So is 31.189, the given Amount, on B,
to 2.0122, Amount of 1 *l.* in the Time, on A.
Againſt which in the *Table* is 12 *Years.*

PROB. IV.

Given an Annuity, Time, and Rate. } *To find the Arrearages.*

EXample. *What ſhall* 33 *l. Annuity forborn* 14 *Years Amount to at* 6 *l.* per Cent. per Ann?

As .06, the Annual Intereſt of 1 *l.* on B,
is to 1.261, the Amount of 1 *l.* in 12 years
per *Table* leſs 1, on A;
So is 33, the given Annuity, on B,
to 693.5, the *Arrearages*, on A.

And when the *Rent* is payable *Half Yearly*, or *Quarterly*, the *firſt Term* in the *Proportion* muſt be the *Intereſt* of 1 *l.* for *Half a Year*, or *Quarter* accordingly, *&c.*

And the *Intereſt* of 1 *l.* for	*a Year*,	at 6 *l.* per Cent. is	.06	at 8 *l.* per Cent. is	.08
	3 *Quart.*		.04467		.05942
	½ *Year*,		.02956		.03923
	a Quarter.		.01467		.01943

PROB. V.

Given the Arrearages, Time and Rate: } *To find the Annuity.*

EXample. *If the Arrearages in* 14 *Years be* 693.5 *l. at* 6 *l.* per Cent. per Ann. *what is the Annuity?*

As 1.261, the Amount of 1 *l.* in 14 Years *per Table* leſs 1, on B,
is to .06, Annual Intereſt of 1 *l.* in a Year, on A;
So is 693.5, the given Arrearages, on B,
to 33, the *Annuity*, on A.

PROB.

PROB. VI.

Given the Annuity, Arrearages, and Rate: } *To find the Time.*

EXample. *In what Time will* 33 *l.* per Ann. *Amount to* 693. 5 *l. at* 6 *l.* per Cent. per Ann?

As 33, the given Annuity, on B,
is to 693.5, the given Arrearages, on A;
So is .06, the Intereſt of 1 *l.* in a Year, on B,
to 1.261 on A, to which add an Unit.

And againſt 2.261 the Sum in the *Table* is 14 the *Time.*

PROB. VII.

Given an Annuity, Time, and Rate: } *To find its preſent Worth.*

EXample. *What is an Annuity of* 33 *l.* per An. *to continue* 14 *Years Worth in ready Mony, allowing* 6 *l.* per Cent. per Ann.

As .13566, the Fact of the Intereſt and Amount of 1 *l.* in the Time, on B,
is to 1.261, the Amount of 1 *l.* in 14 Years, per *Table* leſs 1, on A;
So is 33, the given Annuity, on B,
to 396.74, the *preſent Worth*, on A.

PROB. VIII.

Given the preſent Worth, Time, and Rate: } *To find the Annuity.*

EXample. *What Annuity to continue* 14 *Years will* 306.74 *l. Purchaſe at* 6 *l.* per Cent. per Ann?

As 1.261, the Amount of 1 *l.* in 14 Years *per Table* leſs 1, on B,
is to .13566, Fact of .06 into 2.261, on A;
So is 306.74, the preſent Worth, on B,
to 33, the *Annuity*, on A.

PROB. IX.

Given an Annuity, preſent Worth, and Rate: } *To find the Time.*

EXample. *In what Time will an Annuity of* 33 *l.* per Ann. *diſcharge a Debt of* 306.74 *l. allowing* 6 *l.* per Cent. per Ann?

As 14.5392, the Annuity leſs the Fact of .06 into its preſent Worth, on B,
is to 33, the given Annuity, on A;
So is 1 on B,
to 2.261, Amount of 1 *l.* in the Time, on A.
Againſt which in the *Table* is 14 the *Years*.

PROB.

PROB. X.

Given an Annuity to commence at the expiration of any Time to come, and to continue any given Time: } *To find its preſent Worth at any Rate of Intereſt.*

EXample. *There is an Annuity of* 32 *l.* per Ann. *to begin at the end of* 7 *Years, and to continue for* 21 *Years, what is it worth in ready Money at* 6 *l.* per Cent. per Ann?

By *Prob.* VII. The *preſent Worth of* 1 *l. Annuity for* 28 *Years at* 6 *l.* per Cent. *is* 13.4062 *l.*

7 *Years at* 6 *l.* per Cent. *is* 5.5823 *l.*

The difference is the preſent Worth of 1 *l.* Annuity for 21 Years at the end of 7 Years — 7.8239 *l.*

As 1 on B,
is to 7.8239, the Difference found, on A;
So is 32, the given Annuity, on B,
to 250.36, the *preſent Worth*, on A.

PROB. XI.

Given a Sum of Money payable at any Time to come: } *To find what Annuity to Commence preſently, and to continue any given Time, that Sum will Purchaſe at any Rate of Intereſt.*

EXample. *What Annuity to begin preſently and continue* 10 *Years will* 500 *l. Purchaſe payable at the expiration of Years at* 6 *l.* per Cent?

By *Prob.* II. the preſent Worth of 500 *l.* due 4 years hence at 6*l. per Cent.* is } 396.046 *l.*

And by *Prob.* VIII. 396.046 will Purchaſe an Annuity at 6 *l. per Cent.* to continue 10 Years of } 53.81 *l.*

PROB. XII.

Given a Leaſe with the Time of its Continuance, Fine, and Rent: } *To find what Rent the ſaid Leaſe is valued at any Rate of Intereſt.*

EXample. *There is a Leaſe for* 25 *Years at* 150 *l. Fine, and* 40 *l. Rent* per Ann. *payable Yearly, What Rent is it Worth throughout the whole Term?*

By

By *Prob.* VIII. 150 *l.* Fine will at 6 *l.* *per Cent.* for 25 Years buy a Rent of — } 11.733 *l.*
To which add the old Rent ——— 40.

The Sum is the *Annual Rent* ——— 51.733 *l.*

PORB. XIII.

Given a Leaſe in Reverſion after any given Time, with the Fine, and Rent: } *To find the Value thereof when it comes into Poſſeſſion at any Rate of Intereſt.*

EXample. *Suppoſe one pay* 160 *l. Fine, and* 20 *l.* per Ann. *for a Leaſe in Reverſion after* 13 *Years; what will it ſtand him when it comes to be in Poſſeſſion at the Rate of* 6 *l.* per Cent?

By *Prob.* I. the Amount of 160 *l.* In 13 Years is ——— } 341.269

By *Prob.* IV. the Arrearages of 20 *l.* the Annuity in 13 Years at 6 *l. per Cent.* } 377.643

The Sum is the *Value* required ——— 718.912

PROB. XIV.

Given a Leaſe for any Term in Reverſion after any Time aſſigned, with a Fine, and the Rent payable all the Time the Leaſe is in Reverſion: — *To find what Rent (either with the like Fine, or without) the Leaſe muſt Yield for the Leſſee to Gain after any Rate of Intereſt.*

The Canon is Two fold.

1. *When the like Fine is received.*

EXample. *If for a Leaſe of* 21 *Years in Reverſion after* 13 *Years to come, One pay* 160 *l. ready Mony, and* 20 *l.* per Ann. *during the* 13 *Years: What Annual Rent with* 160 *l. Fine muſt he (when the Leaſe comes to be in Poſſeſſion) receive for the* 21 *Years, ſo as to have* 6 *l.* per Cent. *for his Mony?*

By *Prob.* XIII. the Leaſe when it comes into Poſſeſſion will be Worth at 6 *l. per Cent.* —— 718.912 *l.*

The given Fine Subſtract —— 160.

The Remainder is —— 558.912 *l.*

And by *Prob.* VIII. 558.912 *l.* will Purchaſe an *Annual Rent* for 21 *Years* at 6 *l. per Cent.* of —— 47.508 *l.*

2. *When*

2. *When no Fine is received.*

Example. *If for a Leaſe of* 21 *Years in Reverſion after* 13 *Years to come, one pay* 160 *l. ready Mony, and* 20 *l.* per Ann. *during the* 13 *Years: What Annual Rent without a Fine muſt he ſet the Premiſes at (when the Leaſe comes into Poſſeſſion) ſo as to gain after the Rate of* 6 *l.* per Cent?

By *Prob.* XIII. the Leaſe when it comes to be in Poſſeſſion will be worth at 6 *l. per Cent.* —— } 718.912 *l.*

And by *Prob.* VIII. 718.912 will Purchaſe an *Annual Rent* for 21 *Years* at 6 *l. per Cent.* of —— } 61.108 *l.*

PROB. XV.

Given the Term of a Leaſe, Fine, and Rent: } *To Increaſe the Rent in proportion to any Abatement of the Fine, or the Fine in proportion to any Abatement of the Rent, according to any Rate of Intereſt.*

The Canon is Two-fold.

1. *To encreaſe the Rent in proportion to the Diminution of the Fine.*

EXample. *If a Leaſe be worth* 250 *l.* Fine, *and* 44 *l. Rent* per Ann. *payable Yearly for* 14 *Years,*

and the Tenant be deſirous to encreaſe the Rent to 20 *l.* per Ann. *What Fine muſt he pay allowing* 6 *l.* per Cent?

By *Prob.* VII. The preſent Worth of 24 *l.* the Difference of the Rents to continue 14 Years at 6 *l. per Cent.* — } 223.08 *l.*
To which add the given *Fine* ——— 250.

The Sum is the *Fine* ſought ——— 473.08 *l.*

2. *To encreaſe the Fine in proportion to the Diminution of the Rent.*

Example. *If a Leaſe be worth* 153 *l. Fine, and an Annual Rent of* 16 *l. payable Yearly for* 21 *Years, and the Tenant is willing to decreaſe the Fine to* 50 *l. What Rent ſhall he Pay allowing* 6 *l.* per Cent. per Ann?

By *Prob.* VIII. 103 *l.* the Difference of the Fines will at 6 *l. per Cent.* Purchaſe an Annuity for 21 Years of —— } 8.755 *l.*
To which add the given Rent ——— 16.

The Sum is the *Rent* required ——— 24.755 *l.*

PROB. XVI.

Given a Leaſe whereof ſome of the Term is of leſs Value than the other: } *To find its preſent Worth at any Rate of Intereſt?*

EXample. *There is a Leaſe for* 17 *Years which yields* 28 *l.* per Ann. *but after* 8 *years it will yield* 36 *l.* per Ann. *for the Reſidue of the Term: What is it worth in ready Mony allowing* 6 *l.* per Cent. per Ann? By

By *Prob.* VII. The preſent Worth of 36 *l.* the greater Rent for 17 Years the whole Term of the Leaſe at 6 *l. per Cent.* } 377.181 *l.*

The preſent Worth of 8 *l.* the Difference of the Rents for 8 Years that part of the Leaſes Term for which the leſſer Rent is to continue at 6 *l. per Cent.* } 49.678 *l.*

The Difference is the *preſent Worth* 327.503 *l.*

PROB. XVII.

Given the Fine of a Leaſe for any Term: } *To find what Fine in proportion to the former the ſame Leaſe is Worth for any greater or leſſer Term, at any Rate of Intereſt?*

EXample. *If a Leaſe to continue* 30 *Years be worth* 200 *l. Fine, and a certain Annual Rent: What Fine is it Worth for* 21 *Years not altering the Rent at* 6 *l.* per Cent?

By *Prob.* VIII. 200 *l.* Fine will Purchaſe an Annuity to continue 30 Years at 6 *l. per Cent.* of } 14.53 *l.*

By *Prob.* VII. the preſent Worth of 14.53 *l.* the ſaid Annuity to continue 21 Years the given Term at 6 *l. per Cent.* is the *Fine* } 170.932 *l.*

PROB.

PROB. XVIII.

Given a Leaſe charged with ſeveral Quit-Rents, and Payments, at divers Times being upon Sale: } *To find what abatement is to be made out of the Value agreed on, in Lieu of thoſe Incumbrances at any Rate of Intereſt?*

EXample. *The Value of a Farm is* 900 *l. but ſtanding charged with theſe ſeveral Quit-Rents,* viz. 20 *l.* per Ann. *for* 3 *Years, and after that* 28 *l.* per Ann. *for* 7 *years: How much muſt be abated in Lieu of theſe Incumbrances allowing* 6 *l.* per Cent?

By *Prob.* VII. the preſent Worth of 20 *l. per Ann.* for 3 Years is ——— } 49.173 *l.*

And the preſent Worth of 28 *l. per Ann.* for 7 Years at 6*l. per Cent.* is — } 156.307 *l.*

Then by *Prob.* II. diſcompt for the 13 Years to expire before the Commencement thereof, and the Value is — } 131.240 *l.*

The Sum is the *Abatement* required — 180.413 *l.*

PROB.

PROB. XIX.

Given a Sum of Mony: } *To find what Annual, Half Yearly, or Quarterly Rent of a Freehold Eſtate it will Purchaſe at any Rate.*

EXample. *If* 1300 *l. be laid out in a Freehold at* 6 *l.* per Cent. per Ann. *What is the Annual Rent?*

As 1 on B,
is to .06, the Intereſt of 1 *l.* for a Year, on A;
So is 1300, the given Sum, on B,
to 78, the *Annual Rent*, on A.

PROB. XX.

Given the Purchaſe Mony, and the Annual, Half Yearly, or Quarterly Rent of a Freehold Eſtate: } *To find the Rate of Intereſt?*

EXample. *If* 1300 *l. be given for a Freehold whoſe Annual Rent is* 78 *l. what is the Rate of Intereſt?*

As 1300, the Purchaſe Mony, on B,
is to 1 on A;
So is 78, the Annual Rent, on B,
to .06, the Rate of Intereſt, on A.

Or

Or having the Number of Years Purchaſe to find the Rate, & Cont.

As 20, the Years Purchaſe, on B,
is to 1 on A;
So is 1 on B,
to .05, the *Rate of Intereſt*, on A.
And as .05, the Rate of Intereſt, on B,
is to 1 on A;
So is 1 on B,
to 20, the *Years Purchaſe*, on A.

And ſo for any other number of *Years*, or *Rate* of *Intereſt*.

If the Payments be *Half Yearly*, or *Quarterly* then (inſtead of 1) uſe .5 or .25.

CHAP. V.

Uſe of the Rule in Trigonometry.

TRigonometry *teaches how to meaſure all manner of Triangles whether Plain, or Spherical, by comparing their Sides, and Angles together, according to their known Proportions.*

1. *A plain Triangle* is deſcribed on a *plain Surface*, whoſe *Sides* are *right Lines*, and is either *Right-angled* as A B C Fig. 1. or *Oblique-angled* as A C B Fig. 2. and the *Oblique* is either *Acute*, or *Obtuſe*.

2. The

2. The *Lines* about the Triangle are called *Sides*, or *Legs*, but in *Right-Angled-Triangles* A C the Side ſubtending the *Right-Angle* in Fig 1. is called the *Hypotenuſe*, A B the Bottom Line the *Baſe*, and B C the upright Line the *Perpendicular*. And are meaſured by ſome Scale of equal parts, as of *Inches*, *Feet*, *Yards*, *Perches*, &c.

3. An *Angle* is an *Arch* of a *Circle* deſcribed on the *Angular Point*, and cutting both the *Sides* including the *Angle*, and is meaſured by a *Line* of *Chords*.

4. In all *Right-Angled-Triangles*, the *Right-Angle* is always equal to the *other two*, and therefore they are the *Complement* of one another to 90 *Degrees*.

5. In all *plain Triangles*, the *three Angles* are equal to *two Right-Angles*, therefore if any *two Angles* be given, the *third* is alſo given, it being the *Complement* of the other two to 180 *Degrees*.

6. In all *Plain Triangles* the *Sines* of the *Angles* are Proportional to their *oppoſite Sides*, & Contra.

§. 1. *Of Rectangular Plain Triangles.*

PROB. I. Fig. 1.

Given the Angles, and one Side: } *To find the other Parts.*

Example. { *Angles* { A 36°.52' / C 53.08 } / *Side* AB 280 } *To find and* A C B C.

As 53°.08', the Angle C, on S,
is to 280, the Side A B, on D;
So is 90°.00', the Radius, on S,
to 350, the *Hypotenuſe* A C, on D.

And

And ſo is 36°.62′, the Angle A, on S,
to 210, the *Perpendicular* B C, on D.
Which is *Inches*, *Feet*, *Yards*, &c. according as the *Side* was taken.

PROB. II. Fig. 1.

Given the Angles, and Hypotenuſe: } *To find the Sides.*

Example. { *Angles* { A 36°.52′ / C 53. 08 } / *Hypotenuſe* A C 350 } *To find* A B, *and* B C.

As 90°.00′, the Radius, on S,
is to 350, the Hypotenuſe, on D;
So is 53°.08, the Angle C, on S,
to 280, the *Baſe* A B, on D.
And ſo is 36°.52′, the Angle A, on S,
to 210, the *Perpendicular* B C, on D.

PROB. III. Fig. 1.

Given the Baſe, and Perpendicular: } *To find the other Parts.*

Example. { *Baſe* A B 280 / *Perpend.* B C 210 } *To find the Ang.* A, *and* A C *the Hypoten.*

1. As 280, the Baſe, on D,
is to 45°.00′, the Radius, on T;
So is 210, the Perpendicular, on D,
to 36°.52, the *Angle* A, on T.
2. As 36°.52′, the Angle A, on S,
is to 210, the Perpendicular, on D;
So is 90°.00′, the Radius, on S,
to 350, the *Hypotenuſe* A C, on D.

PROB.

PROB. IV. Fig. 1.

Given the Hypotenuſe, and one Side: } *To find the other Parts.*

EXample. { *Hypoten.* A C 350 / *Baſe* . . A B 280 } *To find the Angles* C *and* A, *and the Perpendicular* B C.

As 350, the Hypotenuſe, on D,
is to 90°.00′, the Radius, on S;
So is 280, the Baſe, on D,
to 53°.08′, the *Angle* C, on S.
Whoſe Compl. to 90°.00′ is 36°52′ the *Angle* A.
And by *Prob.* II. the *Perpendicular* B C is 210.

§. 2. *Of Oblique Angular Plain Triangles.*

PROB. V. Fig. 2.

Given two Angles, and a Side: } *To find the other Parts.*

EXample. { *Angles* { C 122°.00′ / B 14. 40 } / *Side* A C 100 } *To find the Baſe* A B.

1. As 14°.40′, the Angle B, on S,
is to 100, the Side A C, on D;
So is 58°.00′, the Compl. of the Angle C, on S,
to 335, the *Baſe* A B, on D.
And ſo is 43°.20′, the Angle A, on S,
to 271.1, the *Side* B C, on D.

PROB.

PROB. VI. Fig. 2.

Given two Sides, and an Angle opposite to one of them: } *To find the other Parts.*

EXample. { *Sides* { A C 100 / B C 271.1 } *Angle* B 14°.40′ } *To find the Angle* A, *&c.*

1. As 100, the Side A C, on D,
is to 14°.40′, the Angle B, on S;
So is 271.1, the Side B C, on D,
to 43°.20′, the Angle C, on S.

And 58°.00′ (the Sum of the Angles A and B) taken from 180°,00′ leaves 122°.00′ the *Angle* C.

2. As 43°.20′, the Angle A, on S,
is to 271.1, the Side B C, on D,
So is 58°.00′, the Angle C, on S,
to 335, the *Base* A B, on D.

Note, If the given *Angle* be *Obtuse* the *opposite Side* will be greater than either of the other, and the other *Angles* will be *Acute*.

But if the given *Angle* be *Acute*, it will be doubtful to find whether the *Angle opposite* to the *greater Side* be *Right*, *Acute*, or *Obtuse*, therefore to be certain of what Quality it is delineate the *Triangle* truly, and you have your Desire.

PROB.

PROB. VII. Fig. 2.

Given two Sides, and the included Angle: } *To find the other Parts.*

EXample. { *Sides* { A C 100 / B C 271.1 } / *Angle* C 122°.00′ } *To find the Angle* A, *&c.*

As 371.1, Sum of the Sides A C and B C, on D,
is to 29°.00′, the Semi-sum of the unknown Angles, on T;
So is 171.1, the Difference of the Sides, on D,
to 14°.20′, the *Semi-difference of the unknown Angles*, on T.

And { more / less } 29°.00′ { } 14°.20′ is { 43°.20′ / 14.40 } the Angle { A / B }

And by *Prob.* II. the Base is 335.

PROB. VIII. Fig. 2.

Given the three Sides: } *To find the Angles.*

EXample. *Sides* { A B 335 / A C 100 / B C 271.1 } *To find the Angles.*

As 335, the true Base or greater Side, on B,
is to 371.1, the Sum of the other Sides, on D,
So is 171.1, the Difference of the Sides, on B,
to 189.4, the *Alternate Base* B E, on D.

From

From A B the true Baſe or greater Side —— 355
Subſtract B E the *Alternate Baſe* —— 189.4

The Remainder is B D —— 145.6

The half of which is the *Baſe* A D —— 72,8
To which add B E the *Alternate Baſe* —— 149.4

The Sum is the *Baſe* B D —— 262.2

Thus this *Oblique Triangle* A C B is reduced into two *Right-Angled-Triangles, viz.* A D C, and B D C, in either of which you have the *Hypotenuſal*, and *Baſe*, and a *Right-Angle* given to find the other Parts.

§. 3. *Of Rectangular Spherical Triangles.*

1. *A Spherical Triangle* is deſcribed on the *Surface of a Sphere*, whoſe *Sides* are *Arches of three great Circles*, and is either *Right-Angled* as A B C Fig. 3. Or *Oblique-Angled* as A C B Fig. 4. and the *Oblique* is either *Acute*, or *Obtuſe*.

2. The *Arches* about the *Triangle* are called *Sides*, or *Legs*, but in *Rectangular Triangles*, the *Side* which ſubtendeth the *Right-Angle* I call the *Hypotenuſe*, the other two promiſcuouſly the *Baſe*, and *Perpendicular*, and are meaſured by a Line of *Chords*.

3. The Sum of the Sides of a *Spherical Triangle* is leſs than two *Semi-Circles*.

4. In all *Spherical Triangles*, the Sum of the three Angles is greater than two *Right-Angles*, but leſs than *Six*.

5. A *Perpendicular* is part of an Arch of a great Circle, which being let fall from any Angle, divides the *Oblique Triangle* into two *Right-Angled-Triangles*,

gles, and if you make the *greateſt Side* the *Baſe*, then the *Perpendicular* will always fall within the *Triangle*.

PROB. I. Fig. 3.

Given the Hypotenuſe, and one of the Oblique-Angles: } *To find the Side next it.*

EXample. { *Hypotenuſe* A C 30°.00′ } *To find* A B
{ *Angle at Baſe* A 23.30 } *the Baſe.*

As 90°.00′, the Radius, on SS,
is to 30°.00′, the Hypotenuſe, on T;
So is 66°.30′, the Compl. of the Angle A, on SS,
to 27°.54′, the *Baſe* A B, on T.

And this is the way of letting fall a *Perpendicular* from an *unknown Angle* upon the *oppoſite Side*.

If the Hypotenuſe exceed 45°,00′ *as ſuppoſe the Hypotenuſe* AC 74°.06, *and the Angle* 57°.47′ *then ſay:*

As 32°,13′, the Compl. of the Angle A, on SS,
is to 74°.06′, the Hypotenuſe, on T;
So is 90°. 00′, the Radius, on SS;
to 61°. 53′, the Baſe A B, on T.

PROB. II. Fig. 3.

Given the Hypotenuſe, and one of the Oblique-Angles: } *To find the oppoſite Side.*

EXample. { *Hypotenuſe* A C 30°.00′ } *To find the*
{ *Angle at Baſe* A 23.30 } *Perpend.* B C.

As

As 90°.00′, the Radius, on S,
is to 30°.00′, the Hypotenuse, on SS;
So is 23°.30′, the Angle A, on S,
to 11°.30′, the *Perpendicular* B C, on SS.

PROB. III. Fig. 3.

Given the Hypotenuse, and one Oblique-Angle: } *To find the other.*

EXample. { *Hypotenuse* A C 30°.00′ } *To find* C *the Angle at the Perpendicul.*
{ *Angle at Base* A 23.30 }

As 90°.00′, the Radius, on SS
is to 23°.30′, the Angle A, on T;
So is 60°.00′, Compl. of the Hypotenuse, on SS,
to 20°.38, the *Compl. of* C, on T.
Therefore the *Angle* C is 69°.22.
If the given Angle exceed 45°.00′, *As if the Angle* C *be given, and the Angle* A *sought, then say:*
As 60°.00, the Compl. of the Hypotenuse, on SS,
is to 69°.22′, the Angle C, on T;
So is 90° 00′, the Radius, on SS,
to 23°.30′, the *Angle* at *the Base*, on T.

PROB. IV. Fig. 3.

Given the Hypotenuse, and one Side: } *To find the other.*

EXample. { *Hypoten.* A C 30°.00′ } *To find* B C *the Perpendicular.*
{ *Base* A B 27.54 }

As

As 62°.06′, the Compl. of the Base, on S,
is to 90°.00′, the Radius, on SS;
So is 60°.00′, the Compl. of the Hypoten. on S,
to 78°.30′, the Compl. of BC, on SS.
Therefore the *Perpendicular* BC is 11°.30′.

PROB. V. Fig. 3.

Given the Hypotenuse, and one Side: } *To find the Angle next it:*

EXample. { *Hypotenuse* AC 30°.00′ } *To find* A *the Angle at* *Base.*
{ *Base* AB 27.54 }

As 30°.00′, the Hypotenuse, on T,
is to 90°.00, the Radius, on SS;
So is 27°.54, the Base, on T,
to 66°.30′, the Compl. of the Angle A on SS.
Therefore the *Angle* A is 23°.30′.

If the Hypotenuse and Side exceed 45°.00′, *as suppose the Hypotenuse* AC 74°.06′, *and the Base* AB, 61°.53′, *then say:*

As 61°.53′, the Base, on T,
is to 90°.00′, the Radius, on SS;
So is 74°.06′, the Hypotenuse, on T,
to 32°.13′, the Compl. of the Angle A, on SS.
Therefore the *Angle* A is 57°.47′.

And after this manner by altering the *Places* of the given *Terms* one way or other, any *Quere* may be resolved.

PROB.

PROB. VI. Fig. 3.

Given the Hypotenuſe, and one Side: } *To find the oppoſite Angle.*

EXample. { *Hypoten.* AC 30°.00′ } *To find* C *the Angle at the Perpendicular.*
{ *Baſe* AB 27.54 }

As 30°.00′, the Hypotenuſe, on S,
is to 90°.00′, the Radius, on SS;
So is 27°.54, the Baſe, on S,
to 69°.22′, the *Angle* C, on SS,

PROB. VII. Fig. 3.

Given two Sides: } *To find the Hypotenuſe.*

EXample. { *Baſe* AB 27°.54′ } *To find* AC *the Hypotenuſe.*
{ *Perpend.* BC 11.30 }

As 90°.00′, the Radius, on S,
is to 62°.06′, the Compl. of the Baſe, on SS;
So is 78°.30′, Compl. of the Perpendicular, on S,
to 60°.00′, Compl. of the Hypotenuſe, on SS.
Therefore the *Hypoteniuſe* AC is 30°.00′.

PROB.

PROB. VIII. Fig. 3.

Given two Sides. } *To find either of the Oblique-Angles.*

EXample. { *Base* AB 27°.54′ } *To find* A *the Angle at the Base.*
{ *Perpend.* BC 11.30 }

As 27°.54′, the Base, on SS,
is to 11°.30′, the Perpendicular, on T;
So is 90°.00′, the Radius, on SS,
to 23°.30′, the *Angle* A, on T,

If the Angle sought exceed 45°.00′, *as doth the Angle* C, *and the Sides be under* 45°.00′, *then the best way to find* C, *is by Prob.* IX *to find the Hypotenuse first.*

But if the Side opposite to the Angle sought exceed 45°.00′, *as suppose the Sides* AB *were* 61.53′, *and* BC 54°.28′, *and the Angle* A *required, then say:*

As 90°.00′, the Radius, on SS,
is to 54°.28′, the Side opposite to the Angle sought, on T;
So is 61°.53′, Side next the Angle sought, on SS,
to 57°.47′, the *Angle* A, on T.

Note, that in Examples of this kind the Angle sought always exceeds 45°.00′.

PROB. IX. Fig. 3.

Given one Side and the Oblique-Angle next it: } *To find the Hypotenuse.*

EXample. { *Base* A B. 27°.54′ } *To find* A C
{ *Angle at Base* A 23.30 } *the Hypoten.*

As 66°.30′, the Compl. of the given Angle, on SS,
is to 27°.54, the given Side, on T;
So is 90°.00′, the Radius, on SS,
to 30°.00′, the *Hypotenuse*, on T.

If the given Side exceed 45°.00′, *as suppose* A B 61°.53, *and the Angle* A 57°.47′, *then say:*

As 90°.00′, the Radius, on SS,
is to 61°.53, the given Side, on T;
So is 32°.13′, the Compl. of the Angle at the Base, on SS,
to 74°.06′, the *Hypotenuse*, A C on T.

PROB. X. Fig. 3.

Given one Side and the Oblique-Angle next it: } *To find the other Side.*

EXample. { *Base* A B 27°.54′ } *To find* B C
{ *Angle at Base* A 23.30 } *the Perpendic.*

As 90°.00′, the Radius, on SS,
is to 23°.30′, the given Angle, on T;
So is 27°.54′, the given Side, on SS,
to 11°.30′, the *Side required*, on T.

PROB.

PROB. XI. Fig. 3.

Given one Side, and the Oblique-Angle next it: } *To find the other Oblique-Angle.*

EXam- { *Base* AB 27°.54′ } *To find the Angle* C.
ple. { *Angle* A 23.30 }

As 90°.00′, the Radius, on S,
is to 62°.06′, Compl. of the given Side, on SS;
So is 23°.30′, the given Angle, on S,
to 20°.38′, the Compl. of C, on SS.
Therefore the *Angle* C is 69°.22′.

PROB. XII. Fig. 3.

Given one Side and the opposite Angle. } *To find the other Side.*

EXam- { *Perpendic.* BC 11°.30′ } *To find* AB
ple. { *Angle at Base* A 23.30 } *the Base.*

As 23°.30′, the given Angle, on T,
is to 90°.00′, the Radius, on SS;
So is 11°.30′, the given Side, on T,
to 27°.54′, the *Side* Sought, on SS.

Sometimes it happens that this *Problem* cannot be resolved by this Proportion by reason of a *great Side* or *Angle*, yet by the *Lines* there are ways to perform it either by Inversion of the Places, or by other *Problems*.

PROB. XIII. Fig. 3.

Given one Side, and the opposite Angle: } *To find the Hypotenuse.*

Example. { *Perpend.* BC 11°.30′ / *Angle at Base* 23.30 } *To find* AC *the Hypotenuse.*

As 23°.30′, the given Angle, on S,
is to 90°.00′, the Radius, on SS;
So is 11°.30′, the given Side, on S,
to 30°.00′, the *Hypotenuse*, on SS.

PROB. XIV. Fig. 3.

Given one Side and the opposite Angle. } *To find the other Angle.*

Example. { *Perpendic.* BC 11°.30′ / *Angle at Base* A 23.30 } *To find the Angle* C.

As 78°.30′, the Compl. of the given Side, on S,
is to 90°.00′, the Radius, on SS;
So is 66°.30′, the Compl of the given Angle, on S,
to 69°.22′, the *Angle* C required, on SS.

PROB. XV. Fig. 3.

Given two oblique Angles: } *To find either Side.*

Example. { *Base* A 23°.30′ / *Angles at Perpend.* C 69.22 } *To find* AB *the Base.*

As

As 23°.30′, the Angle, A on S,
is to 90°.00′, the Radius, on SS;
So is 20°.38′, the Compl. of the Angle C, on S,
to 62°.06′, the Compl. of the Base A B, on SS.
Therefore A B the *Base* is 27°.54′.

PROB. XVI. Fig. 3.

Given two oblique Angles: } *To find the Hypotenuse.*

EXample. { *Base* A 23°.30′ } *To find* A C
Angles at { *Perpend.* C 69.22 } *the Hypotenuse.*
As 23°.30′, the Angle A, on T,
is to 90°.00′, the Radius, on SS;
So is 20°.38′, the Compl. of the Angle C, on T,
to 60°.00′, the Compl. of the Hypotenuse, on SS.
Therefore the *Hypotneuse* A C, is 30°.00′.

§. 4. *Of oblique Angled Spherical Triangles.*

PROB. XVII. Fig. 4.

Given two Sides, and either of the opposite Angles: } *To find the other Angle.*

EXample. { *Sides* { A C 30°.00′ / B C 18.47 } / *Angle* B 38.15 } *To find the Angle* A.
As 30°.00′, the Side A C, on S,
is to 38°.15′, the Angle B, on SS;
So is 18°.47′, the Side B C, on S,
to 23°.30′, the *Angle* A, on SS.

PROB. XVIII. Fig. 4.

Given two Angles, and either of the oppoſite Sides: } *To find the other Side.*

EXample. { *Angles* { B 38°.15′ / A 23.30 } / *Side* A C 30.00 } *To find the Side* B C.

As 38°.15′, the Angle B, on S,
is to 30°.00′, the Side A C, on SS;
So is 23°.30′, the Angle A, on S,
to 18°.47′, the *Side* B C, on SS.

In the Solution of moſt of the following *Problems* the *Oblique Triangle* muſt be reduced into two *Rect-Angled-Triangles*, by letting fall a *Perpendicular* from an *unknown Angle* upon the *oppoſite Side*.

And that *Side* on which the *Perpendicular* falls is always to be the *Baſe*, and muſt be *prolonged* (if need be.)

If the *Angles* at the Baſe are, { Both *Acute* / or both *Obtuſe*, / One *Acute*, and one *Obtuſe*, } The *Perpend.* falls { *within* / *without* } The *Triangle.*

PROB. XIX. Fig. 4.

Given two Sides, and the Angle included: } *To find the third Side.*

EXample. { *Sides* { A C 30°.00′ / A B 42.51 } / *Angle* A 23.30 } *To find the Side* B C.

Here

Here by letting fall the *Perpendicular* C D, from the *unknown Angle* C, upon the *oppoſite Side* A B, the *Oblique Triangle* A C B is reduced into two *Rect-Angled-Triangles, viz.* A D C and B D C.

By *Prob.* 1, the *Baſe* A D will be 27°.54′, and (becauſe the *Perpendicular* falls within) from A B 42°.51′, take A D 27°.54′, the Remainder is 14°.57′ the *Alternate Baſe* B D, then:

As 62°.06′, the Compl. of the Baſe A D, on S,
is to 60°.00′, the Compl. of the Side Ac, on SS;
So is 75°.03′, the Compl. of the Baſe B D, on S,
to 71°.13′, the Compl. of the Side B C, on SS.
Therefore the *Side* B C is 18°.47′.

PROB. XX. Fig. 4.

Given two Sides and the Angle included: } *To find either of the other Angles.*

Example. { *Sides* A C 30°.00′, A B 42.51 } *To find the Angle* B.
{ *Angle* A 23.30 }

By *Prob.* 1. the *Baſe* A D is 27°.54′, and (becauſe the *Perpendicular* falls within) A B 42.51 leſs A D 27°.54′, is 14°.57′, the *Baſe* B D, then:

As 14°.57′, the Alternate Baſe B D, on SS,
is to 23°.30′, the Angle A, on T;
So is 27°.54′, the Baſe A D, on SS,
to 38°.15′, the *Angle* B, on T.

If the Sum of the included Sides exceed 180°. *Subſtract each Side ſeverally from* 180°. *and work with thoſe Complements as with the Sides, and you will have the Complement of each Angle to* 180°.

PROB. XXI. Fig. 4.

Given two Sides and either of the opposite Angles. } *To find the third Side.*

Example. { *Sides* AC 30°.00′, BC 18.47 } *To find* AB *the Base.* { *Angle* A 23.30

By *Prob.* I. The *Base* AD is 27°.54′.

As 60°.00′, the Compl of AC, on S,
is to 62°.06, the Compl of AD, on SS;
So is 71°.13′, the Compl. of BC, on S,
to 75° 03, the Compl. of BD, on SS.

Therefore the *Base* BD is 14°.57′. Which added to 27°.54′ (becauſe the *Perpendicular* falls within) gives 42°.51′ the *Base* AB.

PROB. XXII. Fig. 4.

Given two Sides and either of the opposite Angles: } *To find the Angle included.*

Example. { *Sides* AC 30°.00′, BC 18.47 } *To find the Angle* C. { *Angle* A 23 30

By *Prob.* III The Angle ACD is 69°.22′.

As 18°.47′, the Side BC, on T,
is to 20°.38′, Compl. of the Angl. ACD, on SS;
So is 30°.00′, the Side AC, on T,
to 36°.46′, Compl. of the Angl. BCD, on SS.

Therefore the *Angle* BCD is 53°.14′. Which added to 69°.22′ (becauſe the *Perpendicular falls* within) gives 122°.36′ the *Angle* ACB.

PROB.

PROB. XXIII. Fig. 4.

Given two Angles and the Side included: } *To find either of the other Sides.*

Example. { *Angles* { A 23°.30′ / C 122.36 } / *Side* AC 30.00 } *To find the Side* BC.

By *Prob.* III. The *Angle* ACD is 69°.22′, which ſubſtracted from 122°.36′, leaves 53°.14′ the *Angle* BCD, then:

As 36°.46′, the Comp. of the Angle BCD, on SS,
is to 30°.00′, the Side AC, on T;
So is 20°.38′, the Comp. of the Angl. ACD, on SS,
to 71°.13′, the Compl. of BC, on T.
Therefore the Side BC is 18°.47′.

If the Sum of the containing Angles exceed 180°. *Subſtract each Angle ſeverally from* 180°. *and proceed with the Complements as with the Angles, and you will have the Complement of each Side to* 180°.

PROB. XXIV. Fig. 4.

Given two Angles and the Side included: } *To find the third Angle.*

Example. { *Angles* { BAC 23°.30′ / ACB 122.36 } / *Side* AC 30.00 } *To find the Angle* ABC.

By *Prob.* III. The *Angle* ACD is 69°.22′, which ſubſtracted from 122°.36′ (becauſe the *Perpendicular* falls within) leaves 53°.14′ the *Angle* BCD, then:

As 69°.22′, the Angle A C D, on S,
is to 66°.30′, Compl. of the Angle B A C, on SS;
So is 53°.14′, the Angle B C D, on S,
to 51°.45′, Comp. of the Angle A B C, on SS.
Therefore the *Angle* A B C is 38°.15′.

PROB. XXV. Fig. 4.

Given two Angles, and one of the oppoſite Sides: } *To find the Side included.*

Example. { *Angles* { B A C 23°.30′ / A B C 38.15 } / *Side* A C 30.00 } *To find the Side* A B.

By *Prob.* I. The *Baſe* A D is 27°.54′, then:
As 38°.15′, the Angle A B C, on T,
is to 27°.54′, the Baſe A D, on SS;
So is 23°.30′, the Angle B A C, on T;
to 14°.57′, the *Baſe* B D, on SS.
Which added to 27°.54′ (becauſe the Perpendicular falls within) the Sum 42°.51′ is the *Side* A B.

PROB. XXVI. Fig. 4.

Given two Angles and either of the oppoſite Sides: } *To find the third Angle.*

Example. { *Angles* { B A C 23°.30′ / A B C 38.15 } / *Side* A C 30.00 } *To find the Angle* A C B.

By

By *Prob.* III. A C D is 69°.22′, then:
As 66°.30′, the Compl. of the Angle B A C, on S,
is to 69°.22′, the Angle A C D, on SS;
So is 51°.45′, the Compl. of the Angle A B C, on S,
to 53°.14′, the Angle B C D, on SS.
Which added to 69°.22′, gives 122°.36′, the *Angle* A C B.

PROB. XXVII. Fig. 4.

Given the three Sides: } *To find either of the Angles.*

Example. *Sides* { A C 36°.00′ / B C 18.47 / A B 42.51 } *To find the Angle* A C B.

Their Sum is 91.38

The Half is 45.49
A B Side oppos. to the Angle sought } 42.51

The Difference is 2.58, which reserve, then say:
1. As 90°.00, the Radius, on S,
is to 30°.00′, one of the Sides including the Angle sought, on SS;
So is 18°.47, the other Side on S,
to 9°.16, a *Fourth Sine*, on SS.
2. As 9°.16′, the fourth Sine, on S.
is to 45°.49′, the Semi-Sum of the Sides, on SS;
So is 2°.58′, the reserved Difference, on S,
to 13°.20′, a *seventh Sine*, on SS.

Then divide the Space on S between 13°20′, and 90°.00′, into two equal parts, and the Compass point will rest on 28°.42′, whose Compl. 61°.18′, doubled makes 122°.36′, the *Angle* A C B. But

But by help of a Line of *Verſed Sines*, this troubleſome operation may be avoided, for if you find 13°.20′, the *ſeventh Sine* on the Stock on *Sines*, over againſt it on V. *Sines* is 122°.36′, the *Angle* required as before.

PROB. XXVIII. Fig. 4.

Given the three Angles: } *To find either of the Sides.*

IF you take the Complement of the greateſt Angle next the Side required to 180°.00′, the *Angles* will change themſelves into *Sides*, and the *Sides* into *Angles*, and by conſequence the Operation is the ſame as in *Prob.* XXVII.

CHAP. VI.

Uſe of the Rule in Planometry.

SECT. I.

PLanometry is an Art by which the Contents of all Superficies are diſcovered, and is valued by the Square of ſome known Meaſure; as a ſquare Inch, Foot, Yard, Perch, &c.

§. 1. *Of*

§. 1. *Of Board, Glaſs, &c.*

Board, Glaſs, Marble, and Freeſtone Pavements, are meaſured by the Foot Square (each Foot containing 144 Square Inches.)

PROB. I. Fig. 5.

Given a Board whoſe { *Breadth* B D 2.5, *Length* A B 15.25 } *To find the Superficial Content.*

As 1 on B,
is to 2.5, the Breadth, on A;
So is 15.25, the Length, on B,
to 38.12, the *Content*, on A in *Square Inches, Feet, Yards, Perches*, &c. according as the *Dimenſions* were taken in *Inches, Feet*, &c.

PROB. II. Fig. 5.

Given a Board whoſe { *Breadth* B D 30 *Inches*, *Length* A B 183 } *To find the Content in Square Feet.*

As 144, the *Square Inches in a Foot*, on B,
is to 30, the Breadth in Inches, on A;
So is 183, the Length in Inches, on B,
to 38.12, the *Content in Feet*, on A.

PROB.

PROB. III. Fig. 5.

Given a Board whose { *Breadth* B D 30 *Inches* / *Length* A B 15.25 *Feet* } *To find the Cont. in Square Feet.*

As 12, the *Inches in a Foot*, on B,
is to 30, the Breadth in Inches, on A;
So is 15.25, the Length in Feet, on B,
to 38.12, the *Content in Feet*, on A.

Or by the Table, p. 88.

As 1, on B,
is to 15.25, the Length in Feet, on A;
So is 2.5, the Tab. number against 30 the Bredth, on B,
to 38.12, the *Content in Feet*, on A.

If the Board be broader at one end than at the other, take half the Sum of the Bredths for a Mean.

PROB. IV.

Given the Bredth of an Oblong 30 *Inches:* *To find the Content of one Foot Square in Length.*

As 12, the *Inches in one Foot*, on B,
is to 1 on A;
So is 30, the Bredth in Inches, on B,
to 2.5, the *Content* on A.

And

And opening the *Compasses* to this Distance, and turning them to the end of the *Board* you will find how many *Feet* it is in *Length.*

PROB. V.

Given an Oblong whose Bredth is { 2.12 *Feet* / 25.45 *Inches* } *To find how much in Length will make a Square Foot.*

1. As 2.12, the Bredth in Feet, on B,
is to 1 on A;
So is 1 on B,
to .472, the *Length in Feet*, on A.
2. As 25.45, the Bredth in Inches, on B,
is to 144, the Square Inches in a Foot, on A;
So is 1 on B,
to 5.66, the *Length* in *Inches*, on A.

Or by the Lines B *and* D *by inspection.*

Draw out the *Slider* marked B S, and put it in the contrary way, setting 1 on B to 10 on D; Then against any *Bredth* in *Feet*, or *Yards* on one Line (it matters not which) is the *Length* on the other.

Given *Bredth* be { *more* / *less* } than a *Foot*, the Length of a *Foot Square* is { *less* / *more* } than a *Foot.*

Inch;

Inch. of Br.	*Superficial Content of one Foot in Length.*				
	.0	.1	.2	.3	.4
1	0.0833	0.0916	0.1000	0.1083	0.1166
2	0.1666	0.1750	0.1833	0.1916	0.2000
3	0.2500	0.2583	0.2666	0.2750	0.2833
4	0.3333	0.3416	0.3500	0.3583	0.3666
5	0.4166	0.4250	0.4333	0.4416	0.4500
6	0.5000	0.5083	0.5166	0.5250	0.5333
7	0.5833	0.5916	0.6000	0.6083	0.6166
8	0.6666	0.6750	0.6833	0.6916	0.7000
9	0.7500	0.7583	0.7666	0.7750	0.7833
10	0.8333	0.8416	0.8500	0.8583	0.8666
11	0.9166	0.9250	0.9333	0.9416	0.9500
12	1.0000	1.0083	1.0166	1.0250	1.0333
13	1.0833	1.0916	1.1000	1.1083	1.1166
14	1.1666	1.1750	1.1833	1.1916	1.2000
15	1.2500	1.2583	1.2666	1.2750	1.2833
16	1.3333	1.3416	1.3500	1.3583	1.3666
17	1.4166	1.4250	1.4333	1.4416	1.4500
18	1.5000	1.5083	1.5166	1.5250	1.5333
19	1.5833	1.5916	1.6000	1.6083	1.6166
20	1.6666	1.6750	1.6833	1.6916	1.7000
21	1.7500	1.7583	1.7666	1.7750	1.7833
22	1.8333	1.8416	1.8500	1.8583	1.8666
23	1.9166	1.9250	1.9333	1.9416	1.9500
24	2.0000	2.0083	2.0166	2.0250	2.0333
25	2.0833	2.0916	2.1000	2.1083	2.1166
26	2.1666	2.1750	2.1833	2.1916	2.2000
27	2.2500	2.2583	2.2666	2.2750	2.2833
28	2.3333	2.3416	2.3500	2.3583	2.3666
29	2.4166	2.4250	2.4333	2.4416	2.4500
30	2.5000	2.5083	2.5166	2.5250	2.5333
31	2.5833	2.5916	2.6000	2.6083	2.6166
32	2.6666	2.6750	2.6833	2.6916	2.7000
33	2.7500	2.7583	2.7666	2.7750	2.7833
34	2.8333	2.8416	2.8500	2.8583	2.8666
35	2.9166	2.9250	2.9333	2.9416	2.9500

Inch. of Br.	*Superficial Content of one Foot in Length.*				
	.5	.6	.7	.8	.9
1	0.1250	0.1333	0.1416	0.1500	0.1583
2	0.2083	0.2166	0.2250	0.2333	0.2416
3	0.2916	0.3000	0.3083	0.3166	0.3250
4	0.3750	0.3833	0.3916	0.4000	0.4083
5	0.4583	0.4666	0.4750	0.4833	0.4916
6	0.5416	0.5500	0.5583	0.5666	0.5750
7	0.6250	0.6333	0.6416	0.6500	0.6583
8	0.7083	0.7166	0.7250	0.7333	0.7416
9	0.7916	0.8000	0.8083	0.8166	0.8250
10	0.8750	0.8833	0.8916	0.9000	0.9083
11	0.9583	0.9666	0.9750	0.9833	0.9916
12	1.0416	1.0500	1.0583	1.0666	1.0750
13	1.1250	1.1333	1.1416	1.1500	1.1583
14	1.2083	1.2166	1.2250	1.2333	1.2416
15	1.2916	1.3000	1.3083	1.3166	1.3250
16	1.3750	1.3833	1.3916	1.4000	1.4083
17	1.4583	1.4666	1.4750	1.4833	1.4916
18	1.5416	1.5500	1.5583	1.5666	1.5750
19	1.6250	1.6300	1.6416	1.6500	1.6583
20	1.7083	1.7166	1.7250	1.7333	1.7416
21	1.7916	1.8000	1.8083	1.8166	1.8250
22	1.8750	1.8833	1.8916	1.9000	1.9083
23	1.9583	1.9666	1.9750	1.9833	1.9916
24	2.0416	2.0500	2.0583	2.0666	2.0750
25	2.1250	2.1333	2.1416	2.1500	2.1583
26	2.2083	2.2166	2.2250	2.2333	2.2416
27	2.2916	2.3000	2.3083	2.3166	2.3250
28	2.3750	2.3833	2.3916	2.4000	2.4083
29	2.4583	2.4666	2.4750	2.4833	2.4916
30	2.5416	2.5500	2.5583	2.5666	2.5750
31	2.6250	2.6333	2.6416	2.6500	2.6583
32	2.7083	2.7166	2.7250	2.7333	2.7416
33	2.7916	2.8000	2.8083	2.8166	2.8250
34	2.8750	2.8833	2.8916	2.9000	2.9083
35	2.9583	2.9666	2.9750	2.9833	2.9916

§. 2. *Of Paving, Plaistering, Painting, &c.*

Paving, Plaistering, Painting, Wainscoting, &c. are measured by the Yard Square (each Yard containing 9 Square Feet.)

PROB. VI. Fig. 5.

			Feet.	
Given a Court Paved whose	*Bredth*	B D	17.5	*To find the Content in Square-Yards.*
	Length	A B	76.5	

As 9, the *Square-Feet in a Yard*, on B.
is to 17.5, the Bredth in Feet, on A;
So is 76.5, the Length in Feet, on B,
to 148.75, the *Content in Yards*, on A.

			Feet.	
Or given a Room Plaistered whose	*Bredth*	*at each end is*	10.5	*To find the Content in Square-Yards.*
	Length		16.5	
	Height	. . .	8.0	

1. As 9, the *Square-Feet in Yards*, on B,
is to 54, Sum of the four Sides in Feet, on A;
So is 8, the Height in Feet, on B,
to 48, *Content of the Sides in Yards*, on B,
2. As 9, the *Square-Feet in a Yard*, on B,
is to 10, 5, the Bredth in Feet, on A;
So is 165, the Length in Feet, on B,
to 19.25, *Cont. of the Cieling in Yards*, on A
Which added to 48 the Sum of the Sides gives 67.25, the whole *Content in Yards.*

Note,

Note, that in *Plaistering* there is no Allowance for *Doors*, *Windows*, or *Chimnies*.

				Feet.	
Or given a Room Painted whose	*Bredth*	*at each end is*		8.0	*To find the Content in Square-Yards.*
	Length			9,5	
	Height . . .			7.0	

As 9, the *Square-Feet in a Yard*, on B,
is to 35, Sum of the four Sides in Feet, on A;
So is 7, the Height in Feet, on B,
to 27.12, the *Content in Yards*, on A.

Note, that in *Painting* the *Dimensions* are best taken with a *String* because of the *Mouldings*.

And *Solid Bodies* being frequently *Painted*, it may not be unnecessary to shew how to find their *Superficial Contents*.

1. As 1 on B,
is to the Length on A;
So is the Sum of the four Sides on B,
to the *Content of a Square-Pillar*, on A.
2. So is the Perifery on B,
to the *Content of a Round-Pillar*, on A.
3. So is the Semi-Sum of the Sides at the Base on B,
to the Content of a *Pyramid*, on A.
4. So is the Semi-Perifery of the Base on B,
to the *Content of a Cone*, on A.
5. As 1 on C,
is to .3183, *Diameter of a Circle whose Perifery is* 1, on D;
So is the given Perifery on C,
to the *Content of a Sphere*, on D.

Or

Feet.

Or given a Pane of Wainſcot whoſe { *Bredth* 3.5, *Length* 6.5 } *To find the Content in Square-Yards.*

As 9, the *Square-Feet in a Yard*, on B,
is to 3.5, the Bredth in Feet. on A;
So is 6.5, the Length in Feet, on B,
to 2,53, the *Content in Yards*, on A,

PROB. VII.

Given an Oblong whoſe Bredth is 1.5 *Feet:* } *To find how much in Length will make a Square-Yard.*

As 1.5, the Bredth in Feet, on B,
is to 9, the Square Feet in a Yard, on A;
So is 1 on B,
to 6, the *Length in Feet*, on A.

§. 3. *Of Flooring, Roofing, Partitioning,* &c.

Flooring, Roofing, Partitioning, and Tiling are meaſured by the Square of Ten, each Square containing 100 *Feet.*

PROB.

PROB. VIII.

Feet.

Given a Floor whose { *Bredth* 15.5 / *Length* 65.5 } *To find the Content in Squares.*

As 100, the *Square-Feet in a Square*, on B,
is to 15.5, the Bredth in Feet, on A;
So is 65.5, the Length in Feet, on B,
to 10.15, the *Content in Squares*, on A.

Feet.

Or given a Building whose { *Bredth* 36 / *Length* 93 } *To find how many Squares of Roofing, or Tiling it contains.*

As 100, the *Square-Feet in a Square*, on B,
is to 54, double the Length of the Rafter in Feet, on A;
So is 93, the Length in Feet, on B,
to 50.22, the *Content in Squares*, on A.

Note, the *Length* of the *Rafter* is always equal to *three fourths* of the *Bredth* of the *Floor*, to which is to be added the *Vallies* and *Eves*.

Feet.

Or given a Timber Building whose { *Bredth* at each end is 36 / *Length* 93 / *Height* . . . 69 } *To find the Content in Squares.*

As

As 100, the *Square-Feet in a Square*, on B,
is to 258, the Sum of the four Sides in Feet, on A;
So is 69, the Height in Feet, on B,
to 178, the *Content in Squares*, on A.

§. 4. *Of Brick-work.*

Brick-work is measured by the Rod-Square, each Rod containing 272.25 Square-Inches.

Note, all *Brick-work* must be reduced to the *Standard measure* of *one Brick* and an *half thick*.

PROB. IX.

Feet.

Given a Wall whose { *Height* 17.25, *Length* 91.5 } *To find the Content in Rods at* 1.5 *Brick thick.*

AS 272.25, the *Tab. number for* 1.5 *Brick*, on B,
is to 17.25, the Height in Feet, on A;
So is 91.5, the Length in Feet, on B,
to 5.8, the *Content in Rods*, &c. on A.

But if the *Wall* were of any other Thickness not exceeding 6 Bricks, then take the proper Number out of the following *Table*.

Bricks

Bricks Thick.	*Sq. Feet in a Rod*	*Bricks Thick.*	*Sq. Feet in a Rod*
0.5	816.75	3.5	116.67
1.0	408.37	4.0	102.09
1.5	272.25	4.5	90.75
2.0	204.19	5.0	81.68
2.5	163.23	5.5	74.25
3.0	136.12	6.0	68.06

Suppose the former Wall 2 *Bricks thick, with a Water Table* 3 *Feet High, and* .5 *a Brick thick.*

1. As 204.19, *Tab. number for* 2 *Bricks*, on B,
   is to 17.25, the Height in Feet, on A;
   So is 91.5, the Length in Feet, on B,
   to 7.73, the *Content in Rods*, &c. on A.
2. As 816.75, *Tab. number for .5 a Brick*, on B,
   is to 3, the Height in Feet, on A;
   So is 91.5, the Length in Feet, on B,
   to .336, *Cont. of the Water Tab. in Rods*, on A.

Which added to 7.73, the Sum 8.066 is the *true Content* of the Wall in *Rods*, &c.

Note, that in Measuring *Brick Buildings*, you must find the *Content* of *each Wall* severally, and substract from it the *Contents* of all the *Doors* and *Windows*.

Example. *There is a Brick Building in which the Walls to the first Floor are as followeth:*

		Feet		Feet	
The Front Wall 16.75 *Feet long and* 3 *Bricks thick*	*with a Door*	2.75	*and two Windows each*	3.5	*Wide.*
		6.5		6.5	*High*

Fee

		Feet		Feet
The Back Wall 16.75 Feet long and 3.5 Bricks thick	with a Door	2.75	and one Window,	3.5 Wide. 5.5 High.
		6.5	Another	3.0 Wide. 6.0 High.

The Side Walls are each 24.75 Feet long, 2 Bricks thick. And the Height of the Floor 9.5 Feet. To find the Content in Rods, &c.

I. *For the Front Wall.*

1. As 136.12, *Tab. number for* 3 *Bricks*, on B,
is to 9.5, the Height in Feet, on A;
So is 16.75, the Length in Feet, on B,
to 1.169, the *Content in Rods*, &c. on A.

2. As 136.12, on B,
is to 2.75, the Width of the Door in Feet, on A;
So is 6.5, the Height in Feet, on B,
to .131, *Content of the Door in Rods*, on A.

3. As 136.12, on B,
is to 3.5, Width of the Windows in Feet, on A;
So is 6.5, the Height in Feet, on B,
to .167, on A.

Which doubled (*becauſe the Wall is of one Thickneſs*) gives .334 the *Content of both Windows in Rods.*

And .465 the Sum of the *Door* and *Windows* taken from 1.169 the *Content* of the *Wall* leaves .704 the *true Content* of the *Front-Wall* at 1.5 Brick thick.

II. *For*

II. *For the Back Wall.*

1. As 116,67, *Tab. number for* 3.5 *Bricks*, on B,
is to 9.5, the Height in Feet, on A;
So is 16.75, the Length in Feet, on B,
to 1.364, the *Content in Rods*, on A.
2. As 116.67, on B,
is to 2.75, Width of the Door in Feet, on A;
So is 6.5, the Height in Feet, on B,
to .153, *Content of the Door in Rods*, on A.
3. As 116.67, on B,
is to 2,5, Width of the Window in Feet, on A;
So is 5.5, the Height, on B,
to .118, *Cont. of one Window in Rods*, on A.
4. As 116.67, on B,
is to 3, Bredth of the Window in Feet, on A;
So is 6, the Height on B,
to .154, the *Content of the other Window in Rods*, on A.

And .425 the Sum of the *Door* and *Windows*, taken from 1.364 the *Content* of this *Wall* leaves .939 the *true Content of the Back Wall at* 1.5 *Brick thick.*

III. *For the Side Wall.*

As 204.19, the *Tab. number for* 2 *Bricks*, on B,
is to 24.75, the Length in Feet, on A;
So is 9.5, the Height in Feet, on B,
to 1.151, on A,

Which doubled (*because they are of like Dimensions*) gives 2.302 the *Content* of the *Side Walls* at 1.5 *Brick thick.*

		Rods	
The *Wall* on the	*Front*	0.704	The Sum 3.945 is the *Content* of the *Brickwork* to the first *Floor* in *Rods*, &c.
	Back	0.939	
	Sides	2.302	

3.945

And after this manner you may find the *Content* of all the *Walls* to each respective *Floor*.

IV. *For the Chimnies.*

If it be a *Wooden Building* where the Wall of the House goes to make the Back of the Chimney, *Girt it round below the Mantle-Tree.*

But if it stand against a *Brick Wall*, *Girt it round to the Wall*, the Wall at the Back being before measured as a part of the Wall of the House.

Ex. *There is a Chimn. whose*	*Girt below the Mantle-Tree* 10.5	Feet	*To find the Cont. in Rods.*
	Height of the Story 9.		
	Thickness of the Jaums 2 Bricks		

As 204.19, the *Tab number for 2 Bricks*, on B,
is to 10.5, the Girt in Feet, on A;
So is 9, Height of the Story in Feet, on B,
to .463, the *Content in Rods*, on A.

V. *For the Shafts.*

Girt it about in the *narrowest Place*, and take that for the *Bredth*, and its *Height* for the *Length* at one Brick thick, then:

As the *Tab. Number for the Bredth*, on B,
is to the Bredth, on A;
So is the Height, on B,
to the *Content*, on A.

For

For all Shafts are measured as Solid pieces of Brick work.

PROB. X.

Given a Wall whose { *Height* 8 *Feet*; *Thickness* 1.5 *Brick* } *To find how many Feet in Length will make a Rod.*

As 8, the Height in Feet, on B,
is to 1, on A;
So is 272.25, *Tab. Numb. for* 1.5 *Brick*, on B,
to 34, the *Length in Feet*, on A.

§. 5. *Of Diverse Geometrical Figures.*

PROB. XI. Fig. 6.

Given a Rombus whose { *Side* . AB 8.5; *Perpend.* CE 3 } *To find the Area.*

A *Rombus is a Figure contained under four equal Sides, but no right Angles, yet the opposite Angles are equal,* viz. *two Acute, and two Obtuse, like a common Quarry of Glass.*

As 1, on B,
is to 3, the Perpendicular, on A;
So is 8.5, the Side, on B,
to 25.5, the *Area*, on A, in *Inches, Feet, Yards*, &c, according as the *Dimensions* were given.

PROB. XII. Fig. 7.

Given a Romboides whose { *Side* . AB 6.4 / *Perpend.* CP 2.3 } *To find the Area.*

A *Romboides is a Figure consisting of unequal Sides, and Angles, having no right Angle, yet the opposite Sides and Angles are equal.*

As 1, on B,
is to 2.3 the Perpendicular, on A;
So is 6.4, the Side, on B,
to 14.72, the *Area*, on A.

PROB. XIII. Fig. 2.

Given a plain Triangle whose { *Base* . AB 30 / *Perpend.* CD 8 } *To find the Area.*

A *Right lined plain Triangle is a Figure contained by three right Lines including three Angles.*

As 1, on B,
is to 4, half the Perpendicular, on A;
So is 30, the whole Base, on B,
to 120, the *Area*, on A.

And this is a *general Rule* for *all manner* of *Triangles*, if you make the *Longest Side* the *Base*.

PROB.

PROB. XIV. Fig. 2.

Given a plain Triangle, whose Sides are 15, 14, 13. *To find the Area.*

Sides	15	Half Sum	6	Differences of the three Sides and the Half Sum.
	14		7	
	13	21	8	
	42			

1. As 1, on B,
   is to 21, the half Sum, on A;
   So is 6, the first Difference, on B,
   to 126, on A.
2. As 1, on B,
   is to 126, the first Product, on A;
   So is 7, the Second Difference, on B,
   to 882, on A.
3. As 1, on B,
   is to 882, the Second Product on A;
   So is 8, the third Difference, on B,
   to 7056, on A.

Which find on D, and against it on C is 84 the *Area.*

PROB. XV. Fig. 8.

Given ABCD *a Trapezium whose* { *Sides* { BC 20.5, AD 12.5 } *Perpen.* AP 8 } *To find the Area, when* AD *is parallel to* BC.

As 1, on B,
is to 8, the Perpendicular, on A;
So is 16.5, Semi-Sum of the parallel Sides, on B,
to 132, the *Area*, on A.

PROB. XVI. Fig. 9.

Given ABDC *a Trapezium whose* { *Diagonal* CB 20.2, *Perpen.* { DE 6, AG 4 } } *To find the Area, when none of the Sides are parallel.*

As 1, on B,
is to 20.2, the Diagonal, on A;
So is 5, Semi-Sum of the Perpendiculars, on B,
to 101, the *Area*, on A.

And every irregular right lined Figure must with *Diagonals* be divided into *Trapezias* and *Triangles*, then find their *Areas* severally, and the Sum is the *Content* of that *Figure*.

PROB.

PROB. XVII. Fig. 10.

Given A B *the Diameter of a Circle* 15 *Inches.* } *To find the Perifery.*

1. A *Circle* is a Figure contained under *one round Line* as A B C D, called the *Perifery*, *Circumference*, or *Perimeter*.

2. The *Center* is a *Point* in the *middle* from whence all *right Lines* drawn to the *Perifery* are equal.

3. A *Diameter* as A B, is a *right Line* drawn thro the *Center*, croſſing the *Perifery*, and dividing the *Circle* into two equal parts.

4. A *Chord or Subtenſe* as C D is a *right Line* croſſing the *Perifery*, and dividing the *Circle* into two unequal parts.

5. A *Verſed Line* as A E is a part of the *Diameter* contained between an Arch of the *Perifery*, and its *Chord*.

6. A *Sector* as A C K D is a part of a *Circle* contained between an Arch of the *Perifery*, and two *Semidiameters* drawn from the *Center*.

7. A *Segment* as C A D is apart of a *Circle*, bounded on one Side by a *Chord*, and on the other by an Arch of the *Perifery*.

As 1, on B,
is to 3.1416, the *Perifery of a Circle whoſe Diameter is* 1, on A;
So is 15 the given Diameter, on B,
to 47.13, the *Perifery*, on A.

The Converse.

As 1, on B,
is to .3183, the *Diameter of a Circle whose Perifery is* 1, on A;
So is 47.13, the Given Perifery, on B;
to 15, the Diameter, on A.

PROB. XVIII. Fig. 11.

Given A B, *the Diameter of a Circle* 15 *Inches.*

To find C D, *the Side of a Square whose Area is equal to the Circle.*

As 1, on B,
is to .8862, *Side of a Square equal to a Circle whose Diameter is* 1, on A;
So is 15, the given Diameter, on B,
to 13.29, the *Side*, on A.

The Converse.

As 1, on B,
is to 1.128, the *Diameter of a Circle the Side of a Square equal* 1, on A;
So is 13.29, the given Side, on B,
to 15, the *Diameter*, on A.

PROB.

PROB. XIX. Fig. 11.

Given A B, *the Diameter of a Circle* 15 *Inches:* } *To find* E F, *the Side of the Square Inscribed.*

As 1, on B,
is to .7071, the *Side of the Square Inscribed the Diameter* 1, on A;
So is 15, the given Diameter, on B,
to 10.6, the *Side*, on A.

The Converse.

As 1, on B,
is to 1.414, the *Diameter, the Side of the Square Inscribed* 1, on A;
So is 10.6, the given Side, on B,
to 15, the *Diameter*, on A.

PROB. XX. Fig. 12.

Given A B, *the Diameter of a Circle* 15 *Inches:* } *To find* C D, *the Side of the equilateral Triangle Inscribed.*

As 1, on B,
is to .866, the *Side of a Triangle Inscribed the Diameter* 1, on A;
So is 15, the given Diameter, on B,
to 12.99, the *Side*, on A.

The Converſe.

As 1, on B,
is to 1.155, the *Diameter the Side of a Triangle Inſcribed* 1, on A;
So is 12.99, the given Side, on B,
to 15, the *Diameter*, on A.

PROB. XXI. Fig. 10.

Given A B, *the Diameter of a Circle* 15 *Inches.* } *To find the Area, or Superficial Content.*

As 1, on C,
is to .7854, the *Area of a Circle whoſe Diameter is* 1, on D;
So is 15, the given Diameter, on C,
to 176.7, the *Area*, on D,

For all Circles are in Proportion one to another as the Squares of their Diameters.

If the *Diameter* on C fall off the Line D, then uſe 10 at the end of the Line.

The Converſe.

As 1, on C,
is to 1,273, the *Square of the Diameter of a Circle the Area* 1, on D;
So is 176.7, the given Area, on C,
to 15, the *Diameter*, on D.

PROB.

PROB. XXII. Fig. 11.

Given A H B G *the Perifery of a Circle* 47.13 *Inches:* } *To find* C D, *the Side of a Square whose Area is equal to the Circle.*

As 1, on B,
is to .2821, the *Side of a Square equal the Perifery* 1, on A;
So is 47.13, the given Perifery, on B,
to 13.29, the *Side*, on A.

The Converſe.

As 1, on B,
is to 3.545, the *Perifery of a Circle, the Side of the Square Equal* 1, on A;
So is 13.29, the given Side, on B,
to 47.13, the *Perifery*, on A.

PROB. XXIII. Fig. 11.

Given A H B G *the Perifery of a Circle* 47.13 *Inches:* } *To find* E F, *the Side of the Square Inſcribed.*

As 1, on B,
is to .2251, the *Side of a Square Inſcribed in a Circle whoſe Perifery* 1, on A;
So is 47.13, the given Perifery, on B,
to 10.6, the *Side*, on A.

The

The Converse.

As 1, on B,
is to 4.443, the *Perif. of a Circle the Side of the Squart Inscribed* 1, on A;
So is 12.99 the given Side, on B,
to 47.13, the *Perifery*, on A.

PROB. XXIV. Fig. 12.

Given A D B C, *the Perifery of a Circle* 47.13 *Inches:* } *To find* C D, *the Side of the Equilateral Triangle Inscribed.*

As 1, on B,
is to .2757, the *Side of a Triangle Inscribed in a Circle whose Perif.is* 1, on A;
So is 47.13, the given Perifery, on B,
to 12.99, the *Side*, on A.

The Converse.

As 1, on B,
is to 3.628, the *Perifery of a Circle the Side of the Triangle Inscribed* 1, on A;
So is 12.99, the given Side, on B,
to 47.13, the *Perifery*, on A.

PROB.

PROB. XXV. Fig. 10.

Given A C B D, *the Perifery of a Circle* 47.13 *Inches*: } *To find the Area, or Superficial Content.*

As 1, on C,
is to .0796, the *Area of a Circle whose Perifery is* 1, on D;
So is 47.13, the given Perifery, on C,
to 176.7, the *Area*, on D.

For all Circles are in Proportion one to another as the Squares of their Peripheries.

If the *Perifery* on C run off the Line D, then uſe 10 at the end of the Line.

The Converſe.

As 1, on C,
is to 12.566, the *Square of the Perifery of a Circle whoſe Area is* 1, on D;
So is 176.7, the given Area, on C,
to 47.13, the *Perifery*, on D.

PROB.

PROB. XXVI. Fig. 13.

Given { AB *Transverse* } *Diameters of an Ellipsis* { *Inches.* 70 } *To find the Area.*
{ CD *Conjugate* } { 50 }

AN *Ellipsis as* ACBD *is a Section of a Cone cut by a Plain thro both Sides of the Triangle under the Vertex.*

As 1.273, the *Square of the Diameter of a Circle whose Area is* 1, on B,
is to 70, the Transverse Diameter, on A;
So is 50, the Conjugate Diameter, on B,
to 2749, the *Area*, on A.

PROB. XXVII. Fig. 13.

Given { AB *Transverse* } *Diameters of an Ellipsis* { *Inches.* 70 } *To find the Perifery* ACBD.
{ CD *Conjugate* } { 50 }

1. AS 70, the Transverse Diameter, on A,
is to 100, the Radius, on the Line markt ○;
So is 50, the Conjugate Diameter, on A,
to 2.71, a *fourth Number*, on the Line ○
2. As 1, on B,
is to 70, the Transverse Diameter, on A;
So is 2.71, the fourth Number, on B,
to 189.7, the *Perifery*, on A.

PROB.

PROB. XXVIII.

Given the Side of any regular Polygon: } *To find the Area, or Superficial Content.*

A *Regular Polygon is a right lined Figure contained under any number of equal Sides.*

N° of Sides	Names of Polygons	Factors.		Diviſors.	
		Area in Inches Side 1.	Area in Ale-Gall Side 1.	Square of the Side Area 1 Inch	Square of the Side Area 1 Gal.
III	*Trigon*	.43301	.001535	2.30940	651.25
IV	*Tetragon*	1.00000	.003546	1.00000	282.00
V	*Pentagon*	1.72048	.006101	.58123	163.91
VI	*Hexagon*	2.59807	.009213	.38490	108.54
VII	*Heptagon*	3.63393	.012886	.27518	77.60
VIII	*Octagon*	4.82843	.017122	.20710	58.40
IX	*Nonagon*	6.18182	.021921	.16176	45.62
X	*Decagon*	7.69421	.027280	.12997	36.65

And having the Areas of theſe Polygons when the Side is 1, the Area of any other Polygon may be readily found, For:

As the Square of the Side of any Polygon,
is to its Area;
So is the Square of the Side of any other like Polygon,
to its *Area* either in Square *Inches*, *Feet*, *Yards*, &c. according as the *Dimenſions* were taken in *Inches*, *Feet*, or *Yards*.

Example

Example Fig. 14.

Let AB, *the Side of a Pentagon be* 50 *Inches.*

As 1, on C,
is to 1.72, the *Area of a Pentagon whose Side is* 1, on D;
So is 50, the given Side, on C,
to 4301, the *Area in Inches*, on D.

If the Side found on C fall off the Line D, then inſtead of 1, uſe 10 at the end of the Line.

The Converſe.

As 1, on C,
is to .5812, the *Square of the Side of a Pentagon whoſe Area is* 1, on D;
So is .4301, the given Area, on C,
to 50, the *Side*, on D.

SECT. II.

Of Surveying.

Surveying is a branch of Geometry, by which the Contents of all Superficies are diſcovered in Acres, &c.

			Feet	
Note, that a	*Statute*	*Perch*	16.5	40 of
	Woodland	contains	18.	which make
	Cuſtomary		20.24	a *Rood*, and
	Iriſh		21.	160 an *Acre.*

PROB.

PROB. I. Fig. 5.

		Perches.	Chains.	
Given ABDC, an Oblong whose	Br. BD	30	7.5	To find the Content in Acres.
	Len. AB	183	45.75	

1. AS 160, the *Perches in an Acre*, on B, is to 30, the Bredth in Perches, on A; So is 183, the Length in Perches, on B, to 34.31, the *Content in Acres*, on A,

2. As 10, the *Chains in an Acre*, on B, is to 7.5, the Bredth in Chains, on A; So is 45.75, the Length in Chains, on B, to 34.31, the *Content in Acres*, on A.

Note, that the *Chain* here intended is Mr. *Gunter's* 4 *Pole Chain* divided into 100 equal parts or Links, which in my Opinion is the moſt eaſie and expeditious, becauſe *one Chain* in *Bredth*, and 10 in *Length* will make a *Statute Acre*.

PROB. II. Fig. 5.

Given ABCD, an Oblong whose	Br. BD	30 Perches		To find the Content in Acres.
	Len. AD	45.75 Chains		

AS 40, the *Perches in a Chain*, on B, is to 30, the Bredth in Perches, on A; So is 45.75, the Length in Chains, on B, to 34.31, the *Content in Acres*, on A.

PROB.

PROB. III. Fig. 5.

Given ABDC *an Oblong whose Bredth* BD { 3.2 *Perches* / 6.56 *Chains* } *To find how much in Length will make an Acre.*

1. As 3.2, the Bredth in Perches, on B,
is to 1, on A;
So is 160, the Perches in an Acre, on B,
to 50, the *Length in Perches*, on A.
2. As 6.56, the Bredth in Chains, on B,
is to 1, on A;
So is 10, the Chains in an Acre, on B,
to 1.53, the *Length in Chains*, on A.

And if the *Length* be given after the same manner you may find the *Bredth*.

PROB. IV. Fig. 2:

		Perches.	*Chains.*	
Given ABC *a Triangle whose*	*Base* AB	183	45·75	*To find the Content in Acres.*
	Perp. CD	30	7.5	

1. As 320, *double the Perches in an Acre*, on B,
is to 30, Perpendicul. in Perches, on A;
So is 183, the Base in Perches, on B,
to 17.15, the *Content in Acres*, on A.

2. As

2. As 20, *double the Chains in an Acre*, on B,
is to 7.5, the Perpendicular in Chains, on A;
So is 45.75, the Base in Chains, on B,
to 17.15, the *Content in Acres*, on A.

PROB. V. Fig. 9.

Given ABDC *a Trapezium whose* { *Diagonal* CB 40 ; *Perpend.* DE 15, AG 8 } *To find the Content in Acres.* *Perches.*

As 320, which is twice 160, on B,
is to 40, the Diagonal, on A;
So is 23, the Sum of the Perpendiculars, on B,
to 2.87, the *Content in Acres*, on A.

PROB. VI. Fig. 10.

Given AB *the Diameter of a Circle* 140 *Perches.* } *To find the Content in Acres.*

As 1, on C,
is to .00491, the *Area of a Circle in Acres whose Diameter is* 1 *Perch*, on D;
So is 140, the given Diameter in Perches, on C,
to 96.23, the *Content in Acres*, on D.

PROB.

PROB. VII. Fig. 13.

Given { A B *Transv.* } *Diameters of an Ellipsis* { *Perches.* 40 / 30 } *To find the Content in Acres.*
{ C D *Conj.* }

AS 207.3, the *Square of the Diam. of a Circle whose Area is* 1 *Acre*, on B, is to 40, Transverse Diamet. in Perches, on A; So is 30, Conjugate Diameter in Perches, on B, to 5.89, the *Content in Acres*, on A.

PROB. VIII.

Given 34.31 *Acres, the Content of a Superficies according to the Statute Perch, of* 16.5 *Feet:* } *To find the Content according to the Woodland Perch of* 18 *Feet.*

AS 18, the *Feet in a Customary Perch*, on C, is to 34.31, Cont. in Statute Acres, on D; So is 16.5, the Feet in a Statue Perch, on C, to 28.83, *Content in Customary Acres*, on D.

The

The Converſe.

As 16.5, the Feet in a Statute Perch, on C,
is to 28,83, Content in Cuſtomary Acres, on D;
So is 18, the Feet in a Cuſtomary Perch, on C,
to 34,31, the *Content in Statute Acres*, on D,

PROB. IX.

Given 34.31 *Acres of* 16.5 *Feet to the Perch, and* 28.83 *Cuſtomary Acres equal thereto:* } *To find how many Feet are in a Cuſtomary Perch.*

As 28.83, the Cuſtomary Acres, on D,
is to 16,5, Feet in a Statute Perch, on C;
So is 34.31, the Statute Acres, on D,
to 18, the *Feet in a Cuſtomary Perch*, on C.

The Converſe.

As 34.31, the *Statute Acres*, on D,
is to 18, the Feet in a Cuſtomary Perch, on C;
So is 28.83, the Cuſtomary Acres, on D,
to 16.5, the *Feet in a Statute Perch*, on C.

PROB.

PROB. X.

Given an Oblong whose { *Cont.* 28.5 *Acres* / *Scale* 10 *in an Inch* } *To find the Content by a Scale of* 12 *in an Inch.*

As 10, the Scale uſed, on C,
is to 28.5, the given Content. on D;
So is 12, the Scale to be uſed, on C,
to 41.0, the *Content ſought*, on D.

PROB. XI. Fig. 5.

Given A B D C *an Oblong whoſe Content is* 34.31 *Statute Acres:* } *To find the Scale by which it was Plotted.*

TAke any Scale at pleaſure, as ſuppoſe that of 10 *in an Inch.*

And by *Prob.* X. you will find the { *Breadth* B D 6.25 / *Length* A B 38.12 / *Content* 23.82 *Acres by Prob.* I. } *Chains.*

Whereas it ſhould be 34.31 therefore ſay:
As 23.82, the Content found, on D,
is to 10, Scale by which it was Plotted, on C;
So is 34,31, the given Content, on D,
to 12, the *Scale required*, on C.

PROB.

PROB. XII. Fig. 5.

Perches.

Given ABDC *an Oblong whose* — *Side* AC 26 — *Content* 676 — *To cut off* 208 *Perches with a Line Parallel to* BD.

As 676, the whole Content, on B,
is 208, the Perches to be cut off, on A;
So is 26, the given Side, on B,
to 8, the *Distance from* A to E, on A.

Draw the Line E F, and the *Oblong* A E F C will contain 208 Perches as required.

And this will hold if it were a *Rombus*, or *Romboides*.

PROB. XIII. Fig. 15.

Perches.

Given ABC *a Triangle whose* — *Base* AB 42 — *Area* 372.7 — *To cut off* 90 *Perches with a Line drawn from the Angle* C *to cut the Base* AB.

As 372.7, the whole Area, on B,
is to 42, the given Base, on A;
So is 90, the Perches to be cut off, on B,
to 10.14, the *Distance from* A to D, on A.

Draw the Line C D, and the *Triangle* A D C will contain 90 *Perches* as required.

PROB.

PROB. XIV. Fig. 16.

Given ABDC, *a Trapezium whose Sides* AB 24, CD 36, BD 16, AC 20. *To find the Length of* BF *and* FD, *which shall divide it into two equal parts by a Line drawn from the middle between* A *and* C, *the Sides* AB *and* CD *being parallel, and the Angles* B *and* D *right Angles.*

As 60, the Sum of AB and CD the parallel Sides, on B,
is to 16, the Side BD, on A;
So is 24, the Side AB, on B,
to 6.4, the Length of FD, on A.
Which taken from BD 16 leaves BF 9.6.

Or *to find the Length of* CE *and* AE, *in* Fig. 17. *the Line being drawn from the middle between* B *and* D.

As 60, the Sum of AB and CD the Parallel Sides, on B.
is to 20, the Side AC, on A;
So is 24, the Side AB, on B,
to 8, the Length of CE, on A.
Which Subſtracted from AC 20 leaves AE 12.

SECT.

SECT. III.

Of Altimetry.

ALtimetry teacheth how any Height whether acceſſible, or inacceſſible may be meaſured.

PROB. I. Fig. 18.

To take an acceſſible Height at one Station by a Semi-Circle.

AN acceſſible Height is that which may be Mechanically meaſured.

Example. *Let* H *repreſent a Tower whoſe Height* A C *is required.*

Having placed the *Inſtrument* at any convenient *Diſtance* from the Foot of the Tower as at B, direct the *Sights* towards A C, and there fix it: Then look up to the Object, and lift the *Index* up or down till thro the *Sights* you ſee the Top of the *Tower* at C, and Note what *Degrees* and *Minutes* the lower part of the *Index* cuts, which ſuppoſe 58°.00′; and that is the Angle of *Altitude* A B C; Then look thro the Sights the contrary way, (the *Inſtrument* being ſtill unmoved) and obſerve the Place you ſee at B; Meaſure the *Diſtance* between B the Place of Standing, and A the Foot of the Tower, which let be 143.7 Feet.

Now the Angle A B C being 58°.00′, the Complement thereof to 90°.00′ is the Angle B C A, 32°.00′, then say:

As 32°.00′, the Angle B C A, on S,
is to 143.7, the Side B A, on D;
So is 58°.00′, the Angle A B C, on S,
to 230, the *Height* A C, on D.

To which add the *Height* of the *Inſtrument*, the Sum is the *true Height*.

PROB. II. Fig. 18.

To take an inacceſſible Height at two Stations.

AN *inacceſſible Height is that which cannot Mechanically be meaſured, by reaſon of ſome Impediment in the Way, as Water,* &c.

Example. *Let* H *be be a Tower whoſe Height is Sought, and you cannot come at it by reaſon of a River.*

At B as near as you can well come to the Baſe, take as in *Prob.* I. the Angle of Altitude A B C 58°.00′, then meaſure from B backward in a right Line any number of Feet, according as the Ground will permit, as ſuppoſe 100 from B to D; And there alſo obſerve the Angle of Altitude C D A 43°.20′.

Now the Angle D B C made by the Stationary Line B D, and the Viſual Lines B C and D C is 122°.00′, it being the Complement of 58°.00 the Angle A B C to 180°.00′.

And the Angle B C D is 14°.40′, it being the Complement of 165°.20, the Sum of the Angles D B C 122°.00′, and C D B 43°.20′ to 180°.00′, then ſay:

1. As

1. As 14°.40′, the Angle B C D, on S,
is to 100, the Side B D, on D;
So is 43°.20′, the Angle C B D, on S,
to 271.1, the *Side* B C, on D.
2. As 90°.00′, the Radius, on S,
is to 271.1, the Side B C, on D;
So is 58°.00′, the Angle C B A, on S,
to 230, the *Height* A C, on D.

SECT. IV.

Of Longimetry.

Longimetry teacheth how the Diſtance between any two Places may be diſcovered.

PROB. I. Fig. 2.

To find the Diſtance from the Obſerver to an inacceſſible Mark at two Stations.

Example. *Let the Place of the Obſerver be at* C, *and let the Diſtance between* C *and* B *be required.*

From C the place of the *Obſerver* meaſure out which way you pleaſe any number of *Feet*, *Yards*, &c. as far as you can conveniently, the further the better, as ſuppoſe from C to A 100.

Then with a *Semi-Circle* placed at C you will find the Angle A C B 122°.00′; and the *Semi-Circle* being placed at A, obſerve the Angle C A B, which you will find to be 43°.20′ the Sum of thoſe two

Angles 165°.20′ Subſtracted from 180°.00′ leaves the Angle A B C 14°.40′, then ſay:

As 14°.40′, the Angle A B C, on S,
is to 100, the Side A C, on D;
So is 43°.20′, the Angle C A B, on S,
to 271.1, the *Side* B C *the Diſtance*, on D,

CHAP. VII.

Uſe of the Rule in Stereometry.

SECT. I.

Stereometry is an Art by which the Contents of all Solids are diſcovered, and is valued by the Cube of ſome known meaſure, as a Cube-Inch, a Cube-Foot, a Cube-Yard, &c.

PROB. I. Fig. 19.

Given A B, *the Side of a Cube* 2.5: } *To find the Solid Content.*

A Cube is a ſolid Figure, conſiſting of ſix ſquare Plains, whoſe Sides, and Angles are all equal like a Dye.

As 1, on C,
is to 2.5, the given Side, on D;
So is 2.5, the ſaid Side, on C,
to 15.625, the *Content*, on D.

Which is *Inches*, *Feet*, *Yards*, &c. according as the *Dimenſions* were taken in *Inches*, *Feet*, &c.

PROB. II. Fig. 20.

Given a Square Priſm whoſe { *Side* . . A B 2.12 ; *Length* E P 15.25 } *To find the Solid Content.*

A *Priſm is a Solid Figure, contained under ſeveral Plains, whoſe Baſes whether Triangular, Quadrangular, or Multangular are Equal, Parallel, and Alike ſituate.*

As 1, on C,
is to 15.25, the Length, on D;
So is 2.12. the given Side, on C,
to 68.62. the *Content*, on D.

If the Side found on C fall off the Line, then inſtead of 1, uſe 10 at the end of the Line D, or this general Number 3.162 (*the Square-Root of Ten times the Square of* 1.)

Example. *Let the Side be* 9 *Tenths, and Length* 20, *then:*

As 10, at the end of the Line, on C,
is to 20, the Length, on D;
So is .9, the given Side, on C,
to 16.2, the *Content*, on D.
Which is *Inches*, *Feet*, &c. according as the *Dimensions* were given in *Inches*, *Feet*, &c.

PROB. III. Fig. 20.

Inches.

Given a Square Prism whose { *Side* .. AB 25.45 ; *Length* EP 183 } *To find the Solid Content in Feet.*

As 41.57. the *Side of a Square whose Content is* 1 *Foot*, on C,
is to 183, the Length in Inches, on D;
So is 25.45, the given Side in Inches, on C,
to 68.62, the *Content in Feet*, on D.

PROB.

PROB. IV. Fig. 20.

Given a Square Prism whose { *Side* AB 25.45 *Inches*, *Length* EP 15.25 *Feet* } *To find the Solid Content in Feet.*

As 12, the *Side of a Square whose Area is* 144 *Inches*, on C,
is to 15.25, the Length in Feet, on D,
So is 25.45, the given Side in Inches, on C,
to 68.62, the *Content in Feet*, on D.

Or by the Table p. 130 *thus:*

As 1, on B,
is to 15.25, the Length in Feet, on A;
So is 4.5, the Table Number against 25.45, on B,
to 68.62, the *Content in Feet*, on A.

If the Side found on C fall off the Line D, then use 12 at the end of the Line, or this general Number 37.95 (*the Square-Root of Ten times the Square of* 12.)

Example. *Let the Side be 9 Inches, and Length 20 Feet, then:*

As 12, at the end of the Line, on C,
is to 20, the Length in Feet, on D;
So is 9, the given Side in Inches, on C,
to 11.25, the *Content in Feet*, on D.

PROB. V. Fig. 20.

Given a Square Prism whose Side AB, { 25.45 *Inches* / 2.12 *Feet* } *To find the Content of one Foot in Length.*

1. As 12, a general Number, on C,
is to 12, the Length, on D;
So is 25.45, the given Side in Inches, on C,
to 54, the *Content in Inches*, on C.

2. As 1, on C,
is to 1, the Length, on D;
So is 2.12, the given Side in Feet, on C,
to 4.5, the *Content in Feet*, on D.

PROB.

PROB. VI. Fig. 20.

Given a Square Prism whose Side A B, { 25.45 *Inches* / 2.12 *Feet* } *To find how much in Length will make a Solid Foot.*

1. As 25.45, the given Side in Inches, on C,
is to 12, on D;
So is 12, a general Number, on C,
to 2.67, the *Length in Inches*, on D.
Or as 25.45, the given Side, on C,
is to 1, on D;
So is 41.57, a general Number, on C,
to 2.67, the *Length in Inches*, on D.

2. As 2.12, the given Side in Feet, on C,
is to 1, in the middle, on D;
So is 1, on C,
to .222, the *Length in parts of a Foot*, on D.

Br. in Inch.	Solid Content of one Foot in Length, the Bredth being given in Inches.				
	.0	.1	.2	.3	.4
1	0.0069	0.0084	0.0100	0.0117	0.0136
2	0.0277	0.0306	0.0336	0.0367	0.0400
3	0.0625	0.0667	0.0711	0.0756	0.0802
4	0.1111	0.1167	0.1225	0.1284	0.1344
5	0.1736	0.1806	0.1877	0.1950	0.2025
6	0.2500	0.2584	0.2669	0.2756	0.2844
7	0.3402	0.3500	0.3600	0.3700	0.3802
8	0.4444	0.4556	0.4669	0.4784	0.4900
9	0.5625	0.5750	0.5877	0.6006	0.6136
10	0.6944	0.7084	0.7225	0.7367	0.7511
11	0.8402	0.8556	0.8711	0.8867	0.9025
12	1.0000	1.0167	1.0336	1.0506	1.0667
13	1.1736	1.1917	1.2100	1.2284	1.2469
14	1.3611	1.3806	1.4002	1.4200	1.4400
15	1.5625	1.5834	1.6044	1.6256	1.6469
16	1.7777	1.8000	1.8225	1.8450	1.8677
17	2.0069	2.0306	2.0544	2.0784	2.1025
18	2.2500	2.2750	2.3002	2.3256	2.3511
19	2.5069	2.5334	2.5600	2.5867	2.6136
20	2.7777	2.8056	2.8336	2.8617	2.8900
21	3.0625	3.0917	3.1211	3.1506	3.1802
22	3.3611	3.3917	3.4225	3.4534	3.4844
23	3.6736	3.7056	3.7377	3.7700	3.8025
24	4.0000	4.0334	4.0669	4.1006	4.1344
25	4.3402	4.3750	4.4100	4.4450	4.4802
26	4.6944	4.7306	4.7669	4.8034	4.8400
27	5.0625	5.1000	5.1377	5.1756	5.2136
28	5.4444	5.4834	5.5225	5.5617	5.6011
29	5.8402	5.8806	5.9211	5.9617	6.0025
30	6.2500	6.2917	6.3336	6.3756	6.4177
31	6.6736	6.7167	6.7600	6.8034	6.8469
32	7.1111	7.1556	7.2002	7.2450	7.2900
33	7.5625	7.6084	7.6544	7.7006	7.7469
34	8.0277	8.0750	8.1225	8.1700	8.2177
35	8.5069	8.5556	8.6044	8.6534	8.7025

Br. in Inch.	Solid Content of one Foot in Length, the Breadth being given in Inches.				
	.5	.6	.7	.8	.9
1	0.0156	0.0177	0.0200	0.0225	0.0250
2	0.0434	0.0469	0.0506	0.0544	0.0584
3	0.0850	0.0900	0.0950	0.1002	0.1056
4	0.1406	0.1469	0.1534	0.1600	0.1667
5	0.2100	0.2177	0.2256	0.2336	0.2417
6	0.2934	0.3025	0.3117	0.3211	0.3306
7	0.3906	0.4011	0.4117	0.4225	0.4334
8	0.5017	0.5136	0.5256	0.5377	0.5500
9	0.6267	0.6400	0.6534	0.6669	0.6806
10	0.7656	0.7802	0.7950	0.8100	0.8250
11	0.9184	0.9344	0.9506	0.9669	0.9834
12	1.0850	1.1024	1.1206	1.1377	1.1556
13	1.2656	1.2844	1.3034	1.3225	1.3417
14	1.4600	1.4802	1.5006	1.5211	1.5417
15	1.6684	1.6900	1.7117	1.7336	1.7556
16	1.8906	1.9136	1.9367	1.9600	1.9834
17	2.1267	2.1511	2.1756	2.2002	2.2250
18	2.3767	2.4025	2.4284	2.4544	2.4806
19	2.6406	2.6677	2.6950	2.7225	2.7500
20	2.9184	2.9469	2.9756	2.0044	3.0334
21	3.2100	3.2400	3.2700	3.3002	3.3306
22	3.5156	3.5469	3.5784	3.6100	3.6417
23	3.8300	3.8677	3.9006	3.9336	3.9667
24	4.1684	4.2025	4.2356	4.2711	4.3056
25	4.5156	4.5511	4.5867	4.6225	4.6584
26	4.8767	4.9136	4.9506	4.9877	5.0250
27	5.2517	5.2900	5.3284	5.3669	5.4056
28	5.6406	5.6802	5.7200	5.7600	5.8000
29	6.0434	6.0844	6.1256	6.1669	6.2084
30	6.4600	6.5025	6.5450	6.5877	6.6306
31	6.8906	6.9344	6.9784	7.0225	7.0667
32	7.3350	7.3802	7.4256	7.4711	7.5167
33	7.7934	7.8400	7.8867	7.9336	7.9806
34	8.2656	8.3136	8.3617	8.4100	8.4584
35	8.7517	8.8011	8.8506	8.9002	8.9500

PROB. VII. Fig. 21.

Given a Parallelepipedon whose { *Bredth* A H 2.5; *Depth* A C 1.8; *Length* A B 15.25 } *To find the Solid Content.*

1. As 1, on B,
is to 2.5, the Bredth, on A;
So is 1.8, the Depth, on B,
to 4.5, the *Area of the Base*, on A.
2. As 1 on B,
is to 15.25, the Length, on A;
So is 4.5, the Area of the Base, on B,
to 68.62, the *Content*, on A.

Which is *Inches*, *Feet*, &c. according as the Dimensions were given in *Inches*, or *Feet*.

Or a *Geometrical Mean* between the *Bredth* and *Depth* is the *Side* of a *Square Equal*, by which and the *Length* you may find the *Content* by *Prob.* II.

PROB. VIII. Fig. 21.

Given a Parallelepipedon whose { *Bredth* A H 30 *Inches*; *Depth* A C 21.6; *Length* A B 183 } *To find the Solid Content in Feet.*

1. As 1, on B,
is to 30, the Bredth in Inches, on A;
So is 21.6, the Depth in Inches, on B,
to 648, the *Area of the Base in Inches*, on A.

2. As

2. As 1728, the Cube Inches in a Foot, on B,
is to 183, the Length in Inches, on A;
So is 648, the Area of the Base in Inches, on B,
to 68.62, the *Content in Feet*, on A.
Or as 144, the Area of the end of a Cubick Foot, on B,
is to 30, the Bredth in Inches, on A;
So is 21.6, the Depth in Inches, on B,
to 4.5, the *Area of the Base in Feet*, on A.
3. As 12, the *Inches in a Foot*, on B,
is to 183, the Length in Inches, on A;
So is 4.5, the Area of the Base in Feet, on B,
to 68.62, the *Content in Feet*, on A.

If the *Base* be any *regular Polygon* find the Area thereof by *Sect* I. *Prob.* XXVIII. as suppose 184.4 Inches, and Length 20 Feet, then:

1. As 144 on B, *Area of the end of a Cubick Foot* is to 1, on A;
So is 184.4, the given Area in Inches, on B,
to 1.28, *Content of a Foot in Length*, on A.

Or by the Table P. 134. thus:

Area of $\left\{\begin{matrix}100.0\\84.0\\0.4\end{matrix}\right\}$ Inches is $\left\{\begin{matrix}.6944\\.5833\\.0028\end{matrix}\right.$

Content of one Foot in Length 1.2805

2. As 1, on B,
is to 20, the Length in Feet, on A;
So is 1.28, Content of a Foot in Length, on B,
to 25.6, the *Content in Feet*, on A.

Solid

Solid Content of one Foot in Length, the Area being given in Inches.

In. Ar	*Feet, &c.*	*In. Ar*	*Feet, &c.*	*Inch Ar.*	*Feet, &c.*	*Inches Area.*	*Feet, &c.*
1	0.0069	36	0.2500	71	0.4930	700	4.8611
2	0.0139	37	0.2569	72	0.5000	800	5.5555
3	0.0208	38	0.2639	73	0.5069	900	6.2500
4	0.0278	39	0.2708	74	0.5139	1000	6.9444
5	0.0347	40	0.2778	75	0.5208	1100	7.6389
6	0.0417	41	0.2847	76	0.5278	1200	8.3333
7	0.0486	42	0.2917	77	0.5347	1300	9.0278
8	0.0555	43	0.2986	78	0.5417	1400	9.7222
9	0.0625	44	0.3055	79	0.5486	1500	10.4167
10	0.0694	45	0.3125	80	0.5555	1600	11.1111
11	0.0764	46	0.3194	81	0.5625	1700	11.8055
12	0.0833	47	0.3264	82	0.5694	1800	12.5000
13	0.0903	48	0.3333	83	0.5764	1900	13.1944
14	0.0972	49	0.3403	84	0.5833	2000	13.8889
15	0.1042	50	0.3472	85	0.5903	2100	14.5833
16	0.1111	51	0.3542	86	0.5972	2200	15.2778
17	0.1180	52	0.3611	87	0.6042	2300	15.9722
18	0.1250	53	0.3680	88	0.6111	2400	16.6667
19	0.1319	54	0.3750	89	0.6180	2500	17.3611
20	0.1389	55	0.3819	90	0.6250	2600	18.0555
21	0.1458	56	0.3889	91	0.6319	2700	18.7500
22	0.1528	57	0.3958	92	0.6389	2800	19.4444
23	0.1597	58	0.4028	93	0.6458	2900	20.1389
24	0.1667	59	0.4097	94	0.6528	3000	20.8333
25	0.1736	60	0.4167	95	0.6597	4000	27.7778
26	0.1805	61	0.4236	96	0.6667	5000	34.7222
27	0.1875	62	0.4305	97	0.6736	6000	41.6667
28	0.1944	63	0.4375	98	0.6805	7000	48.6111
29	0.2014	64	0.4444	99	0.6875	8000	55.5555
30	0.2083	65	0.4514	100	0.6944	9000	62.5000
31	0.2153	66	0.4583	200	1.3889	10000	69.4444
32	0.2222	67	0.4653	300	2.0833	20000	138.8889
33	0.2292	68	0.4722	400	2.7778	30000	208.3333
34	0.2361	69	0.4792	500	3.4722	40000	277.7778
35	0.2430	70	0.4861	600	4.1667	50000	347.2222

PROB. IX. Fig. 21.

Given a Parallelepipedon whose { *Bredth* AH 30. / *Depth* AC 21.6 / *Length* AB 15.25 *Feet.* } *Inc.* { *To find the Solid Content in Feet.* }

1. As 1, on B,
is to 30, the Bredth in Inches, on A;
So is 21.6, the Depth in Inches, on B,
to 648, *Area of the Base in Inches*, on A.

2. As 144, Area of the end of a Cubick Foot, on B,
is to 15.25, the Length in Feet, on A;
So is 648, the Area of the Base in Inches, on B,
to 68.62, the *Content in Feet*, on A.

Or 1. As 144, on B,
is to 30, the Bredth in Inches, on A;
So is 21.6, the Depth in Inches, on B,
to 4.5, the *Area of the Base in Feet*, on A.

2. As 1, on B,
is to 15.25, the Length in Feet, on A;
So is 4.5, the Area of the Base in Feet, on B,
to 68.62, the *Content in Feet*, on A.

Or take a *Geometrical Mean* between the *Bredth* and *Depth*, and by *Prob.* IV. find the *Content*.

PROB.

PROB. X. Fig. 21.

		Inches.	Feet.	
Given a Parallelepipedon whose	Bredth AH	30	2.5	To find how much in Length will make a Foot.
	Depth AC	21.6	1.8	

1. As 12, on B,
is to 30, the Bredth in Inches, on A;
So is 21.6, the Depth in Inches, on B,
to 54, the *Area of the Base in Inches*, on A.

2. As 54, on B,
is to 12, on A;
So is 12, on B,
to 2.67, the *Length in Inches*, on A.

1. As 1, on B,
is to 2.5, the Bredth in Feet, on A;
So is 1.8, the Depth in Feet, on B,
to 4.5, the *Area of the Base in Feet*, on A.

2. As 4.5, on B,
is to 1, on A;
So is 1, on B,
to .222 the *Length in Feet*, on A.

Or find a *Geometrical Mean* between the *Bredth* and *Depth*, and the reſt of the Operation is the ſame as in *Prob.* V.

PROB.

PROB. XI. Fig. 21.

			Feet.	
Given a Parallelepipedon whose	*Bredth*	A H	18	*To find the Solid Content in Yards.*
	Depth	A C	8	
	Length	A B	20	

1. As 9, the *Square Feet in a Yard*, on B,
is to 18, the Length in Feet, on A;
So is 8, the Depth in Feet, on B,
to 16, the *Area of Base in Yards*, on A.

2. As 3, the *Depth of one Yard*, on B,
is to 20, the Length in Feet, on A;
So is 16, the Area of the Base in Yards. on B,
to 106.6, the *Content in Yards, or Loads*, on A.

PROB. XII. Fig. 22.

				To find the Solid Content.
Given a round Tree (or Cylinder) whose	*Diamet.*	A B	1.25	
	Length	E P	8.75	

A *Cylinder as* A B D C *is a Solid Figure, made by the Conversion of the right angled Parallelogram* A P E C *about the Side* E P, *remaining fixed till the Motion end where it began.*

As 1.128, the *Diameter of a Circle whose Area is* 1, on C,
is to 8.75, the Length, on D;
So is 1.25, the given Diameter, on C,
to 10.74, the *Content*, on D.

Which is *Inches*, or *Feet*, &c. according as the *Dimensions* were given in *Inches*, or *Feet*.

If the Diameter found on C fall off the Line D, then use 1.128 at the end of the Line, or this general Number 3.57 (*the Square-root of Ten times the Square of* 1.128378.)

Example. *Let the Diameter be* 9 *Tenths, and Length* 20, *then*:

As 1.128, at the end, on C,
is to 20, the Length, on D;
So is .9, the given Diameter, on C,
to 12.72, the *Content*, on D.

PROB. XIII. Fig. 22.

Inches.

Given a round Tree (or Cylinder) whose { *Diameter* AB 15 / *Length* EP 105 } *To find the Solid Content in Feet.*

As 46.91, the Diameter of a Circle whose Content is 1 Foot, on C,
is to 105, the Length in Inches, on D;
So is 15, the given Diameter in Inches, on C,
to 10.74, the *Content in Feet*, on D.

PROB.

PROB. XIV. Fig. 22.

Given a round Tree (or Cylinder) whose { *Diamet.* AB 15 *Inc.* ; *Length* EP 8.75 *Feet* } *To find the Solid Content in Feet.*

As 13.54, the *Diameter of a Circle whose Area is* 144 *Inches*, on C,
is to 8.75. the Length in Feet, on D;
So is 15, the given Diameter in Inches, on C,
to 10.74, the *Content in Feet*, on D.

Or by the Table, p. 142.

As 1, on B,
is to 8.75, the Length in Feet, on A;
So is 1.227, Tab. Numb. againſt 15 Inches, on B,
to 10.74, the *Content in Feet*, on A.

If the Diameter found on C run off the Line D, then uſe 13.54 at the end of the Line, or this general Number 42.82 (*the Square-root of Ten times the Square of* 13.54.)

Example. *Let the Diameter be* 9 *Inches, and Length* 20 *Feet, then*:

As 13.54, at the end, on C,
is to 20, the Length in Feet, on D;
So is 9 the given Diameter in Inches, on C,
to 8.74, the *Content in Feet*, on D.

PROB.

PROB. XV. Fig. 22.

Given a round Tree (or Cylinder) whose Diameter AB *is* { 19.1 *Inches* / 1.59 *Feet* } *To find the Content of one Foot in Length.*

1. As 13.54, a general Number, on C,
is to 12, the Inches in a Foot, on D;
So is 19.1, the given Diameter in Inches, on C,
to 23.87, the *Content in Inches*, on D.

2. As 1.128, a general Number, on C,
is to 1, on D;
So is 1.59, the Diameter in Feet, on C,
to 1.989, the *Content in Feet*, on D.

PROB. XVI. Fig. 22.

Given a round Tree (or Cylinder) whose Diameter. AB *is* { 15 *Inches* / 1.25 *Feet* } *To find how much in Length will make a Solid Foot.*

1. As 15, the given Diameter, on C,
is to 12, on D;
So is 13.54, a general Number, on C,
to 9.78, the Length, on D.

Or as 15, the given Diameter, on C,
is to 1, on D;
So is 46.91, a general Number, on C,
to 9.78, the *Length in Inches*, on D.

2. As

2. As 1.25, the Diameter in Feet, on C,
is to 1, on D;
So is 1.128, a general Number, on C,
to .815, the *Length in Feet*, on D.

PROB. XVII. Fig. 22.

Given a round Tree (or Cylinder) whose { *Perifery* AGBL 3.927 / *Length* EP . . 8.75 } *To find the Solid Content.*

As 3.545, the *Perifery of a Circle whose Area is* 1, on C,
is to 8.75. the Length, on D;
So is 3.927, the given Perifery, on C,
to 10.74, the *Content*, on D.
And this is either *Inches*, or *Feet* according as the Dimensions were given.

PROB. XVIII. Fig. 22

Given a round Tree (or Cylinder) whose { *Perifery* AGBL 47.13 / *Length* EP . . 105 } *To find the Solid Content in Feet.*

As 147.36, the *Perifery of a Circle whose Content is* 1 *Foot*, on C,
is to 105, the Length in Inches, on D;
So is 47.13, the given Perifery in Inches, on C,
to 10.74, the *Content in Feet*, on C.

Solid

Inch Dia.	Solid Content of one Foot in Length, the Diameter being given in Inches.				
	.0	.1	.2	.3	.4
1	0.0055	0.0066	0.0079	0.0092	0.0107
2	0.0218	0.0241	0.0264	0.0289	0.0314
3	0.0491	0.0524	0.0558	0.0594	0.0630
4	0.0873	0.0917	0.0962	0.1008	0.1056
5	0.1364	0.1419	0.1475	0.1532	0.1590
6	0.1963	0.2029	0.2097	0.2165	0.2234
7	0.2672	0.2749	0.2827	0.2906	0.2987
8	0.3491	0.3578	0.3667	0.3757	0.3848
9	0.4418	0.4517	0.4616	0.4717	0.4819
10	0.5454	0.5564	0.5674	0.5786	0.5899
11	0.6599	0.6720	0.6842	0.6964	0.7088
12	0.7854	0.7985	0.8118	0.8251	0.8386
13	0.9217	0.9360	0.9503	0.9648	0.9793
14	1.0690	1.0843	1.0998	1.1153	1.1310
15	1.2272	1.2436	1.2601	1.2767	1.2935
16	1.3972	1.4138	1.4314	1.4491	1.4669
17	1.5762	1.5948	1.6135	1.6324	1.6513
18	1.7671	1.7868	1.8066	1.8265	1.8465
19	1.9689	1.9897	2.0106	2.0316	2.0527
20	2.1816	2.2035	2.2255	2.2476	2.2698
21	2.4053	2.4282	2.4513	2.4745	2.4978
22	2.6398	2.6638	2.6880	2.7123	2.7366
23	2.8852	2.9104	2.9356	2.9610	2.9864
24	3.1416	3.1678	3.1941	3.2206	3.2472
25	3.4088	3.4361	3.4636	3.4911	3.5188
26	3.6870	3.7154	3.7439	3.7725	3.8013
27	3.9760	4.0055	4.0352	4.0649	4.0947
28	4.2760	4.3066	4.3373	4.3681	4.3991
29	4.5869	4.6186	4.6504	4.6823	5.7143
30	4.9087	4.9415	4.9744	5.0074	5.0405
31	5.2414	5.2753	5.3092	5.3433	5.3775
32	5.5850	5.6200	5.6550	5.6902	5.7255
33	5.9395	5.9756	6.0117	6.0480	6.0844
34	6.3049	6.3420	6.3793	6.4167	6.4542
35	6.6813	6.7195	6.7578	6.7963	6.8349

Inch Dia.	Solid Content of one Foot in Length, the Diameter being given in Inches.				
	.5	.6	.7	.8	.9
1	0.0123	0.0140	0.0158	0.0177	0.0197
2	0.0341	0.0369	0.0398	0.0428	0.0459
3	0.0668	0.0707	0.0747	0.0788	0.0830
4	0.1104	0.1154	0.1205	0.1257	0.1310
5	0.1650	0.1710	0.1772	0.1835	0.1899
6	0.2304	0.2376	0.2448	0.2522	0.2597
7	0.3068	0.3150	0.3234	0.3318	0.3404
8	0.3941	0.4034	0.4128	0.4224	0.4320
9	0.4922	0.5026	0.5132	0.5238	0.5346
10	0.6013	0.6128	0.6244	0.6362	0.6480
11	0.7213	0.7339	0.7466	0.7594	0.7724
12	0.8522	0.8659	0.8793	0.8936	0.9076
13	0.9940	1.0088	1.0237	1.0387	1.0538
14	1.1467	1.1626	1.1786	1.1947	1.2109
15	1.3103	1.3273	1.3444	1.3616	1.3789
16	1.4849	1.5029	1.5211	1.5394	1.5577
17	1.6703	1.6895	1.7087	1.7281	1.7475
18	1.8667	1.8869	1.9072	1.9277	1.9483
19	2.0739	2.0952	2.1167	2.1382	2.1599
20	2.2921	2.3145	2.3370	2.3597	2.3824
21	2.5212	2.5447	2.5683	2.5920	2.6158
22	2.7611	2.7857	2.8104	2.8353	2.8602
23	3.0120	3.0377	3.0635	3.0894	3.1154
24	3.2738	3.3006	3.3275	3.3545	3.3816
25	3.5465	3.5744	3.6024	3.6305	3.6587
26	3.8301	3.8591	3.8882	3.9174	3.9466
27	4.1247	4.1547	4.1849	4.2151	4.2455
28	4.4301	4.4612	4.4925	4.5238	4.5553
29	4.7464	4.7787	4.8110	4.8435	4.8760
30	5.0737	5.1070	5.1404	5.1740	5.2076
31	5.4118	5.4462	5.4808	5.5154	5.5501
32	5.7609	5.7964	5.8320	5.8677	5.9036
33	6.1209	6.1575	6.1942	6.2710	6.2679
34	6.4917	6.5294	6.5672	6.6051	6.6431
35	6.8735	6.9123	6.9512	6.9902	7.0293

Inch Dia.	Solid Content of one Foot in Length, the Compass being given in Inches.				
	.0	.1	.2	.3	.4
10	0.0552	0.0563	0.0574	0.0586	0.0598
11	0.0668	0.0680	0.0693	0.0706	0.0718
12	0.0795	0.0809	0.0822	0.0836	0.0849
13	0.0934	0.0948	0.0962	0.0977	0.0992
14	0.1083	0.1098	0.1114	0.1130	0.1146
15	0.1243	0.1260	0.1276	0.1293	0.1310
16	0.1414	0.1432	0.1450	0.1468	0.1486
17	0.1517	0.1616	0.1634	0.1653	0.1673
18	0.1790	0.1810	0.1830	0.1850	0.1871
19	0.1995	0.2016	0.2037	0.2058	0.2079
20	0.2210	0.2232	0.2255	0.2277	0.2299
21	0.2437	0.2460	0.2483	0.2507	0.2530
22	0.2674	0.2699	0.2723	0.2748	0.2772
23	0.2923	0.2948	0.2974	0.3000	0.3026
24	0.3183	0.3210	0.3236	0.3263	0.3290
25	0.3453	0.3481	0.3509	0.3537	0.3565
26	0.3735	0.3764	0.3793	0.3822	0.3851
27	0.4028	0.4058	0.4088	0.4118	0.4148
28	0.4332	0.4363	0.4394	0.4425	0.4457
29	0.4647	0.4679	0.4711	0.4744	0.4776
30	0.4937	0.5006	0.5040	0.5073	0.5107
31	0.5310	0.5345	0.5379	0.5414	0.5448
32	0.5658	0.5694	0.5729	0.5765	0.5801
33	0.6018	0.6054	0.6091	0.6128	0.6165
34	0.6388	0.6426	0.6463	0.6501	0.6539
35	0.6769	0.6808	0.6847	0.6886	0.6925
36	0.7162	0.7201	0.7241	0.7281	0.7322
37	0.7565	0.7606	0.7647	0.7688	0.7729
38	0.7979	0.8022	0.8064	0.8106	0.8148
39	0.8405	0.8448	0.8491	0.8535	0.8578
40	0.8842	0.8886	0.8930	0.8975	0.9019
41	0.9289	0.9335	0.9380	0.9426	0.9471
42	0.9748	0.9794	0.9841	0.9888	0.9934
43	1.0218	1.0265	1.0313	1.0361	1.0408
44	1.0698	1.0747	1.0796	1.0845	1.0894

Inch. Comp.	Solid Content of one Foot in Length, the Compass being given in Inches.				
	.5	.6	.7	.8	.9
10	0.0609	0.0620	0.0632	0.0644	0.0656
11	0.0730	0.0743	0.0756	0.0765	0.0782
12	0.0863	0.0877	0.0891	0.0905	0.0919
13	0.1007	0.1022	0.1037	0.1052	0.1067
14	0.1161	0.1178	0.1194	0.1210	0.1226
15	0.1327	0.1344	0.1362	0.1379	0.1397
16	0.1504	0.1522	0.1541	0.1559	0.1578
17	0.1692	0.1711	0.1731	0.1751	0.1770
18	0.1891	0.1911	0.1932	0.1953	0.1974
19	0.2101	0.2123	0.2144	0.2166	0.2188
20	0.2322	0.2345	0.2368	0.2391	0.2414
21	0.2554	0.2578	0.2602	0.2626	0.2650
22	0.2797	0.2822	0.2847	0.2872	0.2898
23	0.3051	0.3077	0.3104	0.3130	0.3156
24	0.3317	0.3344	0.3371	0.3398	0.3426
25	0.3583	0.3621	0.3650	0.3678	0.3707
26	0.3880	0.3910	0.3939	0.3969	0.3999
27	0.4179	0.4209	0.4240	0.4270	0.4301
28	0.4488	0.4529	0.4551	0.4583	0.4615
29	0.4809	0.4841	0.4874	0.4907	0.4940
30	0.5140	0.5171	0.5208	0.5242	0.5276
31	0.5483	0.5518	0.5553	0.5588	0.5623
32	0.5837	0.5873	0.5909	0.5945	0.5981
33	0.6202	0.6239	0.6276	0.6313	0.6350
34	0.6577	0.6615	0.6654	0.6692	0.6731
35	0.6964	0.7003	0.7043	0.7082	0.7122
36	0.7362	0.7402	0.7443	0.7483	0.7524
37	0.7771	0.7812	0.7854	0.7896	0.7938
38	0.8191	0.8233	0.8276	0.8313	0.8362
39	0.8622	0.8666	0.8710	0.8753	0.8797
40	0.9064	0.9109	0.9154	0.9199	0.9244
41	0.9517	0.9563	0.9609	0.9655	0.9701
42	0.9981	1.0028	1.0075	1.0123	1.0177
43	1.0457	1.0505	1.0553	1.0601	1.0650
44	1.0943	1.0992	1.1041	1.1091	1.1141

Inch.	*Solid Content of one Foot in Length, the Compass being given in Inches.*				
Comp.	.0	.1	.2	.3	.4
45	1.1190	1.1240	1.1290	1.1340	1.1390
46	1.1693	1.1744	1.1795	1.1846	1.1897
47	1.2207	1.2259	1.2311	1.2363	1.2416
48	1.2732	1.2785	1.2838	1.2892	1.2945
49	1.3268	1.3322	1.3376	1.3431	1.3486
50	1.3815	1.3870	1.3926	1.3981	1.4037
51	1.4373	1.4430	1.4486	1.4543	1.4600
52	1.4942	1.5000	1.5058	1.5115	1.5173
53	1.5523	1.5581	1.5640	1.5699	1.5758
54	1.6114	1.6174	1.6234	1.6294	1.6354
55	1.6716	1.6777	1.6838	1.6899	1.6960
56	1.7330	1.7392	1.7454	1.7516	1.7578
57	1.7954	1.8017	1.8088	1.8144	1.8207
58	1.8590	1.8654	1.8718	1.8783	1.8847
59	1.9236	1.9302	1.9367	1.9432	1.9498
60	1.9894	1.9960	2.0027	2.0093	2.0169
61	2.0563	2.0630	2.0698	2.0765	2.0833
62	2.1142	2.1311	2.1380	2.144[illegible]	2.1517
63	2.1933	2.2003	2.2073	2.2143	2.2213
64	2.2635	2.2706	2.2777	2.2838	2.2919
65	2.3348	2.3424	2.3492	2.3564	2.3636
66	2.4072	2.4145	2.4218	2.4291	2.4364
67	2.4807	2.4881	2.4955	2.5029	2.5104
68	2.5553	2.5628	2.5703	2.5779	2.5854
69	2.6310	2.6386	2.6463	2.6539	2.6616
70	2.7078	2.7155	2.7233	2.7311	2.7388
71	2.7857	2.7936	2.8014	2.8093	2.8192
72	2.8647	2.8727	2.8807	2.8887	2.8961
73	2.9449	2.9530	2.9610	2.9691	2.9772
74	3.0261	3.0343	3.0425	3.0507	3.0589
75	3.1085	3.1167	3.1250	3.1334	3.3147
76	3.1919	3.2003	3.2087	3.2171	3.2256
77	3.2765	3.2850	3.2935	3.3020	3.3106
78	3.3621	3.3707	3.3794	3.3880	3.3969
79	3.4489	3.4576	3.4664	3.4751	3.4839

Inch Comp.	Solid Content of one Foot in Length, the Compass being given in Inches.				
	.5	.6	.7	.8	.9
45	1.1440	1.1491	1.1541	1.1592	1.1642
46	1.1949	1.2000	1.2052	1.2103	1.2155
47	1.2468	1.2521	1.2573	1.2626	1.2679
48	1.2999	1.3052	1.3106	1.3160	1.3214
49	1.3540	1.3595	1.3650	1.3705	1.3760
50	1.4093	1.4149	1.4205	1.4261	1.4317
51	1.4656	1.4713	1.4771	1.4828	1.4885
52	1.5231	1.5289	1.5347	1.5406	1.5464
53	1.5817	1.5876	1.5935	1.5995	1.6054
54	1.6414	1.6474	1.6535	1.6595	1.6656
55	1.7022	1.7083	1.7145	1.7206	1.7268
56	1.7641	1.7703	1.7766	1.7828	1.7891
57	1.8271	1.8334	1.8398	1.8462	1.8526
58	1.8912	1.8976	1.9041	1.9106	1.9171
59	1.9564	1.9630	1.9696	1.9762	1.9828
60	2.0227	2.0294	2.0361	2.0428	2.0495
61	2.0901	2.0969	2.1037	2.1106	2.1174
62	2.1586	2.1655	2.1724	2.1794	2.1864
63	2.2283	2.2353	2.2423	2.2494	2.2564
64	2.2990	2.3061	2.3133	2.3204	2.3276
65	2.3708	2.3781	2.3853	2.3926	2.3999
66	2.4438	2.4511	2.4585	2.4659	2.4733
67	2.5178	2.5253	2.5328	2.5403	2.5478
68	2.5930	2.6006	2.6082	2.6158	2.6234
69	2.6693	2.6770	2.6846	2.6924	2.7001
70	2.7466	2.7544	2.7622	2.7700	2.7779
71	2.8251	2.8330	2.8409	2.8488	2.8568
72	2.9047	2.9127	2.9207	2.9288	2.9368
73	2.9854	2.9935	3.0016	3.0098	3.0180
74	3.0671	3.0754	3.0836	3.0919	3.1002
75	3.1500	3.1584	3.1668	3.1751	3.1835
76	3.2340	3.2425	3.2510	3.2595	3.2680
77	3.3151	3.3277	3.3363	3.3449	3.3535
78	3.4054	3.4140	3.4227	3.4314	3.4401
79	3.4927	3.5015	3.5103	3.5191	3.5279

Inch Comp.	Solid Content of one Foot in Length, the Compass being given in Inches.				
	.0	.1	.2	.3	.4
80	3.5367	3.5456	3.5544	3.5633	3.5722
81	3.6257	3.6347	3.6436	3.6526	3.6616
82	3.7158	3.7248	3.7339	3.7433	3.7521
83	3.8070	3.8161	3.8253	3.8345	3.8437
84	3.8993	3.9085	3.9178	3.9272	3.9365
85	3.9926	4.0020	4.0115	4.0209	4.0303
86	4.0871	4.0966	4.1062	4.1157	4.1253
87	4.1828	4.1924	4.2020	4.2116	4.2213
88	4.2795	4.2892	4.2989	4.3082	4.3185
89	4.3773	4.3871	4.3970	4.4068	4.4167
90	4.4762	4.4861	4.4961	4.5061	4.5161
91	4.5762	4.5863	4.5964	4.6064	4.6165
92	4.6773	4.6875	4.6979	4.7079	4.7181
93	4.7796	4.7898	4.8002	4.8105	4.8208
94	4.8829	4.8933	4.9037	4.9141	4.9246
95	4.9874	4.9979	5.0083	5.0189	5.0295
96	5.0929	5.1035	5.1142	5.1248	5.1354
97	5.1996	5.2103	5.2210	5.2317	5.2425
98	5.3073	5.3182	5.3290	5.3399	5.3507
99	5.4162	5.4271	5.4381	5.4491	5.4601
100	5.5262	5.5372	5.5483	5.5594	5.5705
101	5.6372	5.6484	5.6596	5.6708	5.6820
102	5.7494	5.7607	5.7720	5.7833	5.7946
103	5.8627	5.8741	5.8855	5.8969	5.9083
104	5.9771	5.9886	6.0001	6.0116	6.0232
105	6.0926	6.1042	6.1158	6.1275	6.1391
106	6.2092	6.2209	6.2327	6.2444	6.2562
107	6.3269	6.3387	6.3506	6.3624	6.3743
108	6.4457				

Inch	Solid Content of one Foot in Length, the Compass being given in Inches.				
Comp.	.5	.6	.7	.8	.9
80	3.5811	3.5900	3.5989	3.6078	3.6168
81	3.6706	3.6796	3.6886	3.6977	3.7067
82	3.7612	3.7704	3.7795	3.7886	3.7978
83	3.8530	3.8622	3.8715	3.8807	3.8900
84	3.9458	3.9552	3.9645	3.9739	3.9833
85	4.0398	4.0492	4.0587	4.0682	4.0776
86	4.1348	4.1444	4.1540	4.1635	4.1731
87	4.2310	4.2406	4.2503	4.2600	4.2697
88	4.3283	4.3380	4.3478	4.3576	4.3674
89	4.4266	4.4365	4.4464	4.4563	4.4663
90	4.5261	4.5361	4.5461	4.5561	4.5662
91	4.6266	4.6368	4.6469	4.6570	4.6677
92	4.7283	4.7386	4.7488	4.7590	4.7693
93	4.8311	4.8415	4.8518	4.8622	4.8725
94	4.9350	4.9455	4.9560	4.9664	4.9769
95	5.0400	5.0506	5.0611	5.0717	5.0823
96	5.1461	5.1568	5.1675	5.1782	5.1889
97	5.2533	5.2641	5.2749	5.2857	5.2965
98	5.3616	5.3725	5.3834	5.3943	5.4053
99	5.4710	5.4821	5.4931	5.5041	5.5151
100	5.5816	5.5927	5.6038	5.6149	5.6261
101	5.6932	5.7044	5.7157	5.7269	5.7382
102	5.8059	5.8173	5.8286	5.8400	5.8513
103	5.9198	5.9321	5.9427	5.9541	5.9656
104	6.0347	6.0463	6.0579	6.0694	6.0810
105	6.1508	6.1624	6.1741	6.1858	6.1975
106	6.2679	6.2797	6.2915	6.3033	6.3151
107	6.3862	6.3981	6.4100	6.4219	6.4338

PROB. XIX. Fig. 22.

Given a round Tree (or Cylinder) whose { *Perif.* AGBL 47.13 *Inc.* ; *Length* EP 8.75 *Feet* } *To find the Content in Feet.*

As 42.54, the *Perif. of a Circle whose Area is* 144 *Inches*, on C,
is to 8.75, the Length in Feet, on D;
So is 47.13, the given Perifery in Inches, on C.
to 10.74, the *Content in Feet*, on D.

Or by the Table, p. 144.

As 1, on B,
is to 8.75, the Length in Feet, on A;
So is 1.227, the Tab. Numb. againſt 47.13, on B,
to 10.74, the *Content in Feet*, on A.

PROB. XX. Fig. 22.

Given a round Tree (or Cylinder) whoſe Perifery AGBL, { 60 *Inches* ; 5 *Feet* } *To find the Solid Content of one Foot in Length.*

1. As 42.54, a general Number, on C,
is to 12 on D;
So is 60, the given Perifery in Inches, on C,
to 23.87, the *Content in Inches*, on D.

2. As

2. As 3.545, a general Number, on C,
is to 1, on D;
So is 5, the given Perifery in Feet, on C,
to 1.989, the *Content in Feet*, on D.

PROB. XXI. Fig. 22.

Given a round Tree (or Cylinder) whose Perifery AGBL, { 47.13 *Inc.* / 3.927 *Feet* } *To find how much in Len. will make a Solid Foot.*

1. AS 47.13, the given Perif. in Inches, on C,
is to 12, on D;
So is 42.54, a general Number, on C,
to 9.78, the *Length in Inches*, on D.

Or As 47.13, the given Perifery, on C,
is to 1, on D;
So is 147.36, a general Number, on C,
to 9.78, the *Length in Inches*, on D.

2. As 3.927, the given Perifery in Feet, on C,
is to 1, on D;
So is 3.545, a general Number, on C,
to .815, the *Length in Feet*, on D.

And so many times as this is contained in the *Length*, so many *Feet*, *&c.* doth the *Tree* contain.

PROB. XXII. Fig. 23.

Given a Square Pyramid whose { *Side* A B 4.5 ; *Height* Z P 18 } *To find the Solid Content.*

A Pyramid is a Solid Figure contained under diverse Plains, and from a Triangular, Quadrangular, or Multangular Base decreases equally till it end in a Point at the Vertex.

As 1, on C,
is to 6, one third of the Altitude, on D,
So is 4.5, the given Side, on C,
to 121.5, the *Content*, on D.

And this is either *Inches, or Feet*, according as the Dimensions were taken in *Inches, or Feet.*

If the *Side* found on C run off the Line D, then instead of 1, use 10 at the end of the Line, or this general Number 3.162.

But if the *Base* be any regular *Polygon* not above 10 Sides, find the Area thereof by *Sect.* I. *Prob* XXVIII. which drawn into one Third part of the Height gives the *Solid Content.*

PROB.

PROB. XXIII. Fig. 23.

Inches.

Given a Square Pyramid whose { *Side* AB 18 ; *Height* ZP 540 } *To find the Solid Content in Feet.*

AS 41.57, the *Side of a Square whose Content is* 1 *Foot*, on C,
is to 180, one third of the Altit. in Inc. on D;
So is 18, the given Side in Inches, on C,
to 33.75, the *Content in Feet*, on D.

PROB. XXIV. Fig. 23.

Given a Square Pyramid whose { *Side* AB 18 *Inc.* ; *Height* ZP 45 *Feet* } *To find the Solid Content in Feet.*

AS 12, a general Number, on C,
is to 15, one third of the given Altitude in Feet, on D;
So is 18, the given Side in Inches, on C,
to 33,75, the *Content in Feet*, on D.

If the *Side* found on C fall off the Line D, then use 12 at the end of the Line, or this general Number 37.95.

PROB. XXV. Fig. 23.

		Feet.	
Given a Square Pyramid whose	*Slant Height* Z B	45.9	*To find how much in Length will make a Foot.*
	whole Content	33.75	

1. *If it be ſet off from the Vertex.*

As 33.75, the whole Content, on E,
is to 45.9, the Slant Height in Feet, on G,
So is 1, on E,
to 6.6 the *Length in Feet*, on C.

If it be cut off at any given Number of Feet and Parts, then inſtead of 1, place the given Number of Feet, *&c.*

2. *If be ſet off from the Baſe.*

As 33.75, the whole Content, on E,
is to 45.9, the Slant Height, on C,
So is 32.75, the whole Content leſs 1, on E,
to 45.4, on C.

Which taken from 45.9 the whole *Slant Height* leaves .5 the *Length*.

If it be required to be cut off at any Number of Feet and Parts, then inſtead of Subſtracting 1, you muſt Subſtract the *Feet* and Parts to be cut off.

PROB.

PROB. XXVI. Fig. 24.

Given a Cone whose { *Diam.* A B 180 *Inc.*; *Height* Z P 45 *Feet* } *To find the Solid Content in Feet.*

A *Cone is a Solid Figure, made by the converſion of the Triangle* A P Z *about its Perpendicular* Z P, *abiding fixed till the motion end where it began.*

As 13.54, a general Number, on C,
is to 15, one third of the Altit. in Feet, on D;
So is 180, the given Diameter in Inches, on C,
to 26.45, the *Content in Feet*, on D.

PROB. XXVII. Fig. 23.

Given the Fruſtum of a Square Pyramid whoſe { *Baſes* { A B 18; C D 6 } *Inc.*; *Length* E P 30 *Feet* } *To find the Solid Content in Feet.*

1. As 1, on B,
is to 18, the greater Baſe, on A;
So is 6, the leſſer Baſe, on B,
to 108, a fourth Number, on A.

To which add 48, one third of the *Square* of the *Difference* of the *Sides*, the Sum is 156.

2. As

2. As 144, the Square of 12, on B,
is to 30, the Length in Feet, on A;
So is 156, on B,
to 32.5, the *Content in Feet*, on A.

PROB. XXVIII. Fig. 25.

		Inches.		*Inches.*	
Given the Frustum of a Rectangular Pyramid whose	*Br.* A B	30	E F	20.6	*To find the Content in Feet.*
	B D	21	F H	14.8	
	Length	12 *Feet.*			

1. AS 1, on B,
is to 50.6, Sum of the Bredths, on A;
So is 21.6, the greater Depth, on B,
to 1093, a *fourth Number*, on A.

2. As 1, on B,
is to 21.6, the *greater Depth*, on A;
So is 14.8, the lesser Depth, on B,
to 304.9, a *fourth number*, on A.
Their Sum is 1397.9.

3. As 432 (which is 3 times 144) on B,
is to 12, the Length in Feet, on A;
So is 1397.9, on B,
to 3882, the *Content in Feet*, on A.

When the *Sides* are Proportional it will be:
As A B, is to B D; So is E F, to F H.

PROB.

PROB. XXIX. Fig. 24.

Given the Fruſtum of a Cone whoſe { *Baſes* { AB 18 / CD 6 } *Inc.* / *Length* EP 30 *Feet* } *To find the Solid Content in Feet.*

1. As 1, on B,
is to 18, the greater Baſe, on A;
So is 6, the leſſer Baſe, on B,
to 108, a *fourth Number*, on A.

To which add 48, one third of the *Square* of the *Difference* of *Diameters*, the Sum is 156.

2. As 183.3, the Square of 13.54, on B,
is to 30, the Length in Feet, on A;
So is 156, on B,
to 25.5, the *Content in Feet*, on A.

PROB. XXX. Fig. 23, 24.

Given the Fruſtum of a Pyramid, or Cone { *Baſes* { AB 18 / CD 6 } *Inc.* / *Length* EP 30 *Feet* } *To find* ZP *the Axis.*

As 12, the Difference of Bredths, or Diameters, on B,
is to 18, the greater Baſe, on A;
So is 30, the given Length, on B,
to 45, the *Axis* of the whole *Pyramid, or Cone*, on A.

PROB.

PROB. XXXI. Fig. 10.

Given a Sphere whose Diameter or Axis A B *is* 20 *Inches:* } *To find the Side of a Cube whose Solidity is equal to the Sphere.*

A *Sphere as* A C B D, *is a Solid Figure generated by the Converſion of the Semi-Circle* A C B *about its Axis* A B, *remaining fixed till the motion end where it began.*

As 1, *the Side of a Cube equal to a Sphere whoſe Axis is* 1, on B,
is to .806, on A;
So is 20, the given Axis, on B,
to 16.12, the *Side equal*, on A.

The Converſe.

As 1, on B,
is to 1.241, the *Axis of a Sphere whoſe Solidity is* 1, on A;
So is 16.12, the given Side, on B,
to 20, the *Axis*, on A.

PROB.

PROB. XXXII. Fig. 10.

Given a Sphere whose Axis A B *is* 20 *Inches:* } *To find the Solid Content.*

As 1, on C,
is to .5236, the *Content of a Sphere whose Axis is* 1, on E;
So is 20, the given Axis, on C,
to 4189, the *Content*, on E.

For every Sphere is equal to two thirds of its circumscribing Cylinder.

Note, that { .001857 / .002267 } is a *Factor* for { *Ale* / *Wine* } *Gallons.*

The Converse.

As 1, on C,
is to 1.91, the *Cube of the Axis of a Sphere whose Content is* 1, on E,
So is 4189, the given Content, on C,
to 20, the *Axis*, on E.

Note, that { 538.58 / 444.18 } is a *Factor* for { *Ale* / *Wine* } *Gallons.*

PROB.

PROB. XXXIII. Fig. 10.

Given a Sphere whose Perif. A B C D *is* 62.83 *Inches:* } *To find the Side of a Cube whose Solidity is equal to the Sphere.*

As 1, on B,
is to .2566, the *Side of a Cube equal to a Sphere whose Perif. is* 1, on A;
So is 62.83, the given Perifery, on B,
to 16.12, the *Side equal*, on A.

The Converſe.

As 1, on B,
is to 3.898, the *Perifery of a Sphere whoſe Content is* 1, on A;
So is 16.12, the given Side, on B,
to 62.83, the *Perifery*, on A.

PROB. XXXIV. Fig. 10.

Given a Sphere whoſe Perif. A B C D *is* 62.83 *Inches:* } *To find the Solid Content in Inches.*

As 1, on C,
is to .01689, the *Content of a Sphere whoſe Perifery is* 1, on E;
So is 62.83, the given Perifery, on C,
to 4189, the *Content in Inches*, on E.

Note, that { .00005988 / .00007310 } is a *Factor* for { *Ale* / *Wine* } *Gallons.*

The

The Converſe.

As 1, on C,
is to 59.22, the *Cube of the Perifery of a Sphere whoſe Content is* 1, on E;
So is 4189, the given Content, on C,
to 62.83, the *Perifery*, on on E.

Note, that { 16699.4 / 13679.3 } is a *Factor* for { *Ale* / *Wine* } *Gallons.*

PROB. XXXV. Fig. 10.

Inches.

Given ABCD a Sphere whoſe { *Axis* AB . . 20 ; *Fruſt. Heig.* AE 6 } *To find the Content of the Fruſt.* CAD *in Ale-Gall.*

1. AS 20, the Axis, on D,
is to 100, the Radius, on the Line ●;
So is 6, the Fruſtum's Height, on D,
to .216, a *Segment*, on ●.

2. As 1, on B,
is to 14.86, the Content of the Sphere, on A;
So is .216, the Segment, on B,
to 3.21, the *Cont. of the Fruſt.* CAD, on A.

PROB.

PROB. XXXVI.

Given a Sphere whose Axis is 20 Inches: } *To find the Side of the greateſt Tetraedron that can be Inſcribed in it.*

As 1, on B,
is to .816, the *Side of a Tetraedron Inſcribed whoſe Axis is* 1, on A;
So is 20, the given Axis, on B,
to 16.32, the *Side Inſcribed*, on A.

The Converſe.

As 1, on B,
is to 1.225, the *Axis of a Tetraedron whoſe Side Inſcribed is* 1, on A;
So is 16,32, the given Side, on B,
to 20, the *Axis*, on A.

Names of the Bodies	*Side Inſcribed, Axis* 1	*Axis, Side inſcribed* 1.
Tetraedron	.816	1.225
Octoedron	.707	1.414
Hexaedron	.577	1.732
Icoſaedron	.526	1.902
Dodecaedron	.357	1.802

PROB.

PROB. XXXVII.

Given a Tetraedron whose Side is 40 *Inches:* } *To find the Solid Content in Inches.*

As 1, on C,
is to .118, the *Content of a Tetraedron whose Side is* 1, on E;
So is 40, the given Side, on C,
to 7552, the *Content*, on E.

The Converse.

As 1, on C,
is to 8.474, the *Cube of the Side of a Tetraedron whose Content is* 1, on E,
So is 7552, the given Content, on C,
to 40, the *Side*, on E.

Names of the Bodies	*Solidity the Side* 1.	*Cube of the Side, the Solidity* 1.
Tetraedron	.118	8.474
Octoedron	.471	2.123
Hexaedron	1.000	1.000
Icosaedron	2.300	0.435
Dodecaedron	8.036	0.124

Note, that all Earth Work, as *Cellars*, *Vaults*, &c. are measured by the *Yard Solid*, *viz.* 27 Solid Feet, and so much ought to be a Cart Load.

All

All *Banks*, *Drains*, *Ditches*, *Rampires*, *Parapets*, and *New Rivers*, are wrought by the *Floor* consisting of 18 Feet Square, and one Foot Deep (i. e.) 324 Solid Feet.

SECT. II.

Of Gauging.

Gauging is a branch of Stereometry, by which the Contents of all Solids are discovered in Gallons, of which there are now allowed and used in England *three Sorts*, viz.

The	*Ale and Beer*	*Gallon*	282	*Cube-*
	Wine	containing	231	*Inches.*
	Corn		268.75	

But Dr. *Wyberd* in his *Tactometry*, *p.* 277. 288 affirms the *Wine-Gallon* to be but 224 or 225 at most.

And this gave birth to Mr. *Walker's* experiment in 1688 who caused a brazen Vessel to be made by Mr. *Isaac Carver*, an ingenious Workman, in form of a *Parallelepipedon*, whose *Base* was 4 Inches Square, and *Depth* 14 Inches, (as Mr. *Gunton* had done that for the *Ale-Quart* in the *Exchequer*) by which it was found to contain only 224 Inches, for the Liquor in this Vessel exactly filled the *Standard-Gallon in Guild-Hall*, *London*, (which is unanimously agreed to be the true and ancient Measure) in the presence of th: Right Honourable Sir *John Shorter*, *then Lord Mayor*, Sir *Basil Firebrace Sheriff*, Mr. *Flamsteed*, Mr. *Halley*, and several other learned and worthy Gentlemen.

This

* *This Setled by a Law would improve the Revenue ſome Thouſands* per Annum.

Note, the *Ale Gallon* in *Ireland* contains only 217.6 *Cube-Inches*.

§. 1. *Uſe of the Rule in finding the Areas of diverſe Figures.*

PROB. I. Fig. 26.

Given a Square whoſe Side A B *is* 138 *Inches*: } *To find the Area, or Superficial Content in Ale-Gallons.*

AS 1, on C,
is to .003546, the *Area of a Square whoſe Side is* 1, on D;
So is 138, the given Side, on C,
to 67.5, the *Superficial Content*, on D.

And if the *Side* found on C fall off the Line D, then uſe 10 at the end of the Line, or this general Number 3.162.

Or as 16.79, the Gauge-point, on C,
is to 1, on D;
So is 138, the given Side, on C,
to 67.5, the *Area*, on D.

If the *Side* found on C fall off the Line D, then inſtead of 16.79 uſe this general Number 531 (*the Square-root of Ten times the Square of the Gauge-point*.)

PROB.

PROB. II. Fig. 2.

Given a Triangle whose { *Base* AB 260 (*Inch*); *Perpend.* CD 110 } *To find the Area in Ale-Gallons.*

As 564, which is twice 282, on B,
is to 110, the Perpendicular, on A;
So is 260, the Baſe, on B,
to 50.7, the *Area*, on A.

PROB. III. Fig. 5.

Given an Oblong whoſe { *Length* AB 180 (*Inch*); *Bredth* BD 130 } *To find the Area in Ale-Gallons.*

As 282, the *Inches in a Gallon*, on B,
is to 180, the Length, on A;
So is 130, the Bredth, on B,
to 82.97, the *Area*, on A.

PROB.

PROB. IV. Fig. 10.

Given a Circle whose Diameter A B *is* 40 *Inches:* } *To find the Area, or Superficial Content in Ale-Gallons.*

As 1, on C,
is to .002785, the *Area of a Circle whose Diameter is* 1, on D;
So is 40, the given Diameter, on C,
to 4.45, the *Area*, on D.

If the *Diameter* found on C run off the Line D, then use 10 at the end of the Line, or this general Number 3.162.

Or as 18.95, the *Diameter of a Circle whose Area is* 1, on C,
is to 1, on D;
So is 40, the given Diameter, on C,
to 4.45, the *Area*, on D.

If the *Diameter* found on C fall off the Line D, then instead of 18.95 use this general Number 59.92. (*the Square-root of Ten times the Square of the Gauge-point.*)

Or *according to Esquire* Everard's *Stereometry made easie*, p.

If the Diameter be more than the Gauge-point, and less than 100.

As the Gauge-point on C,
is to 1, in the *first Radius*, on D;
So is any Diameter on C,
to its *Area*, on D.

But if the Diameter be leſs than the Gauge-point, or more than 100.

As the Gauge-point on C,
is to *f*, in the *Second Radius*, on D;
So is any Diameter on C,
to its *Area* on D.

Note, that { 0034 / 17.15 } is a { *Factor* / *Gauge-point* } { *for Wine-* / *Gallons.* }

Or you may find the Area by the Rule thus:

If a Cooler be 13.4 Inches *Diameter*, draw out the *Slider* towards the right hand till the end cut 13.4 on the inſide of the *Stock*, and againſt it ſtands 5 tenths the *Area* in *Ale-Gallons*, and if the *Diameter* exceed 24 Inches, Pin this *Slider* at 24, and draw out the other towards the left hand, and you will find that when the end cuts 30 Inches againſt it ſtands 2.51 *Gallons* the *Area*, and ſo of all others.

PROB. V. Fig. 10.

Given a Circle whoſe { *Diameter* A B 40 / *Verſed Sine* A P. 8 } *Inches* { *To find the Area of the Seg.* C A D / *in Ale Gall.* }

1. AS 40, the given Diameter, on A,
is to the Radius 100, on the Line O;
So is 8, the Verſed Sine, on A.
to .142, a *Segment*, on O.

2. As

2. As 1, on B,
is to 4.45, the Area of the Circle, on A;
So is .142, the Segment, on B,
to .634, the *Area of the Segment*, on A.

PROB. VI. Fig. 13.

Given an Ellipsis whose { *Transverse* / *Conjugate* } *Diameter is* { 70 / 50 } *Inches. To find the Area in Ale-Gallons.*

AS 359, the *Square of the Gauge-point*, on B,
is to 70, the Transverse Diameter, on A;
So is 50, the Conjugate Diameter, on B,
to 9.75, the *Area in Ale-Gallons.* on A.

Or a *Geometrical Mean* between the *cross Diameters*, is the *Diameter of a Circle* whose *Area* is equal to the *Area* of the *Ellipsis*. And 294.1 is the *Square of the Gauge-point* for *Wine-Gallons.*

PROB. VII. Fig. 27.

Given an Ellipsis whose { *Transv. Diam.* AB 70 / *Versed Sine* AE 14 } *Inches. To find the Area of the Segment* HAI *in Ale-Gallons.*

1. AS 70, the Transverse Diameter, on A,
is to the Rad. 100 on the Line mark. O;
So is 14, the given Versed Sine, on A,
to .142, a *Segment*, on O.

2. As 1, on B,
is to 9.75, the Area of the Ellipsis, on A;
So is .142, the Segment, on B,
to 1.38, the *Area in Gallons*, on A.

PROB. VIII. Fig. 13.

Given an Ellipsis whose { *Conjug. Diam.* CD 50 ; *Verſed Sine* CE 8 } *To find the Area of the Seg.* HCI *in Gallons.*

1. AS 50, the Conjugate Diameter, on A,
is to the Radius 100, on the Line marked O;
So is 8, the Verſed Sine, on A,
to .103, a *Segment*, on O.
2. As 1, on B,
is to 9.75, the Area of the Ellipsis, on A;
So is .103, the Segment, on B,
to 1.00, the *Area in Gallons*, on A.

§. 2. *Uſe of the Rule in Gauging diverſe Solids.*

PROB. IX. Fig. 20.

Given a Square Priſm whoſe { *Side* AB 138 ; *Dep.* EP 20 } *To find the Solid Content in Ale-Gallons.*

AS 16.79, the Gauge-point, on C,
is to 20, the Given Depth, on D;
So is 138, the given Side, on C,
to 1357.6, the *Content in Gallons*, on D.

If the *Side* on C fall off the Line D, then inſtead of 16.79 uſe this general Number 53.1, *(the Square-root of Ten times the Square of the Gauge-point.)*

PROB. X. Fig. 21.

Inches.

Given a Parallelepipedon whoſe { *Length* AB 180, *Bredth* AC 130, *Depth* AH 20 } *To find the Solid Content in Ale-Gallons.*

1. As 282, on B,
is to 180, the Length, on A;
So is 130, the Bredth, on B,
to 82.97, the *Area of the Baſe*, on A.

2. As 1, on B,
is to 20, the Depth, on A;
So is 82.97, the Area of the Baſe, on B,
to 1659.4, the *Content in Gallons*, on A.

PROB. XI. Fig. 22.

Inches.

Given a Cylinder whoſe { *Diam.* AB 120, *Depth* EP 36 } *To find the Content in Ale-Gallons.*

As 18.95, the Gauge-point, on C,
is to 36, the Depth, on D;
So is 120, the given Diameter, on C,
to 1,143.6, the *Content in Gallons*, on D.

If the *Diameter* on C run off the Line D, then instead of 18.95 use this general Number 59.92 (*the Square-root of Ten times the Square of the Gauge-point.*)

Example. *If the Diameter be* 80 *Inches, and Depth* 9 *Inches.*

As 59.92, this general Number, on C,
is to 9, the given Depth, on D;
So is 80, the given Diameter, on C,
to 160.4, the *Content in Gallons*, on D.

Note, if the *Diameters* increase by *Tens*, the *Areas* will increase by *Hundreds.*

PROB. XII. Fig. 23.

Inches.

Given a Square Pyramid whose { *Base* AB 112 / *Height* ZP 60 } *To find the Content in Ale-Gallons.*

As 16.79, the Gauge-point, on C,
is to 20, one third of the Height, on D;
So is 112, the given Base, on C,
to 889.6, the *Content in Gallons*, on D.

For every Pyramid is equal to one third of its circumscribing Prism.

PROB.

PROB. XIII. Fig. 24.

Inches.

Given a Cone whose { *Base* A B 100 ; *Height* Z P 90 } *To find the Cont. in Ale-Gallons.*

As 18.95, the Gauge-point, on C,
is to 30, one third of the Height, on D;
So is 100, the given Diameter, on C,
to 835.5, the *Content in Gallons*, on D.

For every Cone is equal to one third of its circumscribing Cylinder.

PROB. XIV. Fig. 24.

Given { Z P, Z E *Axis of the Cone* { A Z B 120.83, C Z D 95.83 } *In.* ; *Cont. of the Cone* A Z B 94.34 *Gal.* } *To find the Content of the Cone* C Z D.

1. As 120.83, the whole Cone's Axis, on D,
is to the Radius 100 on the Line marked Δ;
So is 95.83, the Lesser Cones Axis, on D,
to .499, a *Segment*, on Δ.

2. As 1, on B,
is to 94.34, the Whole Cone's Content, on A;
So is .499, the Segment, on B,
to 47.06, the *Content of the lesser Cone*, on A.

PROB. XV. Fig. 24.

			Inches.	
Given ABCD *the Frust. of a Cone whose*	*Diameters*	AB	29	*To find the Content in Ale-Gallons.*
		CD	23	
	Depth . . .	EP	25	

1. AS 1, on B,
is to 29, the greater Diameter, on A;
So is 23, the lesser Diameter, on B,
to 667, a *fourth Number*, on A.

To which add 12, *one third of the Square of the Difference of Diameters* the Sum is 679.

2. As 359, the Square of the Gauge-point, on B,
is to 25, the Depth, on A;
So is 679, the Sum, on B,
to 47.28, the *Content in Gallons*, on A.

Or on the *Flat* of the *Rule* find 6 the *Difference of Diameters* on the Line of *Inches*, and against it on the Line marked *Frustum of a Cone* is 3.06, which added to 23 the *lesser Diameter* gives 26.06, a *Mean Diameter*, then say:

As 18.95, the Gauge-point, on C,
is to 25, the Depth, on D;
So is 26.06, the Mean Diatmeter, on C,
to 47.28, the *Content in Gallons*, on D.

If the *Bases* are *Elliptical*, find two *Geometrical Means* between the *Conjugates above* and *below*, and the rest of the Work is the same.

PROB.

PROB. XVI. Fig. 24.

Inches.

Given the Fruſtum of a Cone whoſe { *Baſes* { A B 29 / C D 23 } / *Depth* E P 25 } *To find* Z P *the Cone's Axis.*

AS 6, the Difference of Diameters, on B,
is to 25, the Depth, on A;
So is 29, the Greater Diameter, on B,
to 120.83, the *Cone's Axis*, on A.

PROB. XVII. Fig. 24.

Inches.

Given the Fruſtum of a Cone whoſe { *Baſes* { A B 29 / C D 23 } / *Depth* E P 25 / *Wet* R P 12 } *To find* n o *the Diameter of the Liquors Surface.*

AS 25, the Depth, on B,
is to 6, the Difference of Diamet. on A;
So is 12, the Wet Inches, on B,
to 2.88, a *fourth Number*, on A.
Which taken from 29, leaves 26.12 the *Diameter* n o.

PROB. XVIII. Fig. 24.

Given the Fruſtum of a Cone whoſe { *Baſes* { AB 80, CD 71.2 } *Inc.* ; *Depth* EP 30 ; *Content* . 620 *Gall.* } *To find the Dimenſions of another ſuch Fruſt. whoſe Cont. is* 800 *Gallons.*

1. As 620, the Firſt Content, on E,
is to 80, the Greater Diameter, on C;
So is 800, the Second Content, on E,
to 87, the *Greater Diameter*, on C.

2. As 620, the Firſt Content, on E,
is to 71.2. the Leſſer Diameter, on C.
So is 800, the Second Content, on E,
to 77.4, the *Leſſer Diameter*, on C.

3. As 620, the Firſt Content, on E,
is to 30, the Depth, on C;
So is 800, the Second Content, on E,
to 32.63, the *Depth ſought*, on C.

But having the *Firſt* of theſe, the other may be found at one Operation by the Lines A and B thus:

As 80, the Greater given Baſe, on B,
is to 87, the *Greater Baſe* found, on A,
So is 71.2, the Leſſer given Baſe, on B,
to 77.4, the *Leſſer Baſe* ſought, on A.
And ſo is 30 the given Depth, on B,
to 32.63, the *Depth ſought*, on A.
And the ſame may be done for *Caſks*.

PROB.

PROB. XIX. Fig. 28.

		Inches.	Inches.	
Given the Fruſt. of an Elliptical Cone whoſe	*Tranſ. Dia.*	A B 38.4	C D 30.0	*To find the Cont. in Gall.*
	Conj. Dia.	N K 32.0	H I 25.0	
	Depth	E P 25		

1. AS 1, on B,
is to 68.4, the Sum of the Tranſverſe Diameters, on A,
So is 32, the Greater Conjugate Diameter, on B,
to 2188.8, a *fourth Number*, on A.

2. As 1, on B,
is to 32, the Greater Conjugate Diam. on A;
So is 25, the Leſſer Conjugate Diameter, on B,
to 750, a *fourth Number*, on A.

Which added to 2188.8, the Sum is 2938.8 which reſerve:

3. As 1077, *Triple the Square of the Gauge-point*, on B,
is to 25, the Depth, on A;
So is 2938.8, the reſerved Sum, on B,
to 68.22, the *Content in Gallons*, on A.
And as 846, on B,
is to 25, the Depth, on A;
So is 2938.8, on B,
to 86.86, *Content as the Fruſtum of a Pyramid*, on A.

PROB. XX. Fig. 25.

Given a Prismoid whose Bases are Paral. and Alike situate but Disproportional { *Inches.* *Inches.* *Len.* AB 38 : EF 28 ; *Br.* BD 30 : FH 24 ; *Depth* 50 . . . . } *To find the Content in Gallons.*

A *Prismoid is a Solid Figure contained under several Plains, whose Bases are Rectangular Parallelograms, Parallel, and Alike situate.*

1. As 1, on B,
is to 52, the Sum of AB and half EF, on A;
So is 38, the Greater Bredth, on B,
to 1560, a *fourth Number*, on A.

2. As 1, on B,
is to 47, the Sum of EF and half AB, on A;
So is 24, the Lesser Bredth, on B,
to 1128, a *fourth Number*, on A.

Which added to 1560 the Sum is 2688 which reserve.

3. As 846, on B,
is to 50, the Depth, on A;
So is 2688, the reserved Sum, on B,
to 158.87, the *Content of the Prismoid*, on A.

If the *Bases* are *Circular*, or *Elliptical* 'tis called a *Cylindroid*, and the Operation is the same, changing the *Divisor*. For:

As

As 1077, on B,
is to 50, the Depth, on A;
So is 2688, the reserved Sum, on B,
to 124.79, *Content of the Cylindroid*, on A.

And thus you may find the *Content* of *any Tun* whose *Parallel Bases* are *Rectangular Parallelograms*, or *Ellipses*, whether they are *Alike*, or *Unlike*, *Proportional*, or *Disproportional*, *Alike Situate*, or *Inverted*.

PROB. XXI. Fig. 29.

			Inches.	
Given A B C D *a Parabolick Spindle whose*	*Axis*	A B	109.9	*To find the Content in Ale-Gallons.*
	Diam.	C D	29.	

As 18.95, the Gauge-point, on C,
is to 58.62, eight Fifteenths of the Axis, on D;
So is 29, the Diameter, on C,
to 137.3, the *Content in Gallons.* on D.

For every Parabolick Spindle is equal to eight Fifteenths of its Circumscribing Cylinder.

PROB.

PROB. XXII. Fig. 29.

Given ABCD *a Parabolick Spindle whose* { *Axis* . . AB 109.9 ; *Fruſt. Heig.* AE 29.96 } *Inches.* ; *Solid Content* 173.3 *Gall.* } *To find the Con. of the Fruſt.* HAI.

1. AS 109.9 the Axis, on A,
is to the Radius 100, on the Line, marked ( ) ;
So is 29.96, the Fruſtum's Height, on A,
to .129, a *Segment*, on ( ).

2. As 1, on B,
is to 137.3, the Content of the Spindle, on A ;
So is .129, the Segment, on B,
to 17.7, the *Content of the Fruſtum*, on A.

PROB. XXIII. Fig. 27.

Inches.

Given ABCD, *a Spheroid whose* { *Axis* AB 82 ; *Diam.* CD 29 } *To find the Content in Gallons.*

A *Spheroid as* ABCD *is a Solid Figure, generated by the rotation of the Semi-Ellipſis* ACB, *about its Axis* AB *abiding fixed till the motion end where it began.*

As 18.95, the Gauge-point, on C,
is to 54.73, two Thirds of the Axis, on D;
So is 29, the Diameter, on C,
to 128.18, the *Content in Gallons*, on D.

For every Spheroid is equal to two Thirds of its Circumscribing Cylinder.

Or as 538.6. the *Cube of the Axis of a Sphere whose Content is* 1, on C,
is to 82.1, the Axis, on E;
So is 29, the Diameter, on C,
to 128.18, the *Content*, on E.

PROB. XXIV.

Given a Mash-Tun whose { *Inches.* *Side* . . 60, *Diameter* 60 } *To find the Content upon one Inch in Gallons.*

As { 15.43, 17.41 } on C, is to 1, on D; so is 60 the { *Side*, *Dia.* } on C, to the *Area* on D. { 15.12, 11.18 } *Gall*

But if the *Tun* be { *Oblong*, *Ellipt.* } As { 238, 303 } on B, is to the *Len.* on A; So is the *Bredth* on B, to the *Area* on A.

§. 3. *Use of the Rule in Cask-Gauging.*

PROB. XXV. Fig. 27.

			Inches.	
Given a Spheroidal-Cask whose Diameter	*Bung*	CD	29	*To find* AB *the Spheroid's Axis.*
	Head	HI	23	
	Length	EP	50	

1. AGainst 29, the Bung on C, is 841 on D. and against 23 the Head on C, is 529 on D. The Difference of their Squares is 312, against which in the *first Radius* on D is 17.66 its *Square-root* on C.

2. As 17.66, the Square-root, on B,
is to 25, the Cask's Semi-length, on A;
So is 29, the Bung Diameter, on B,
to 41.05, the *Spheroid's Semi-Axis*, on A.

PROB. XXVI. Fig. 27.

Given a Spheroid whose	*Axis* . : .	AB 82.1	*Inches.*	*To find the Solidity of the Frustum* HAI.
	Frust. Heig.	AE 16.05		
	Solid Cont. .	128.18 *Gall.*		

1. AS 82.1, the Spheroid's Axis, on D,
is to 100, the Radius, on the Line marked ●;
So is 16.05, the Frustums Height, on D,
to .0997, a *Segment*, on ●.

2. As

2. As 1, on B,
is to 128.18, the Spheroids whole Cont. on A.
So is 0.997, the Segment, on B,
to 12.775, the *Content of the Fruſt.* on A.

PROB. XXVII. Fig. 27.

Given a Spheroid whoſe { *Diameter* C D 29. / *Fruſt. Heig.* C E 8.5 / *Solid Cont.* . . . 128.18 } *Inches. Gall.* — *To find the Solidity of the Fruſtum* HCI.

1. AS 29, the Diameter, on D,
is to 100, the Radius, on the Line marked ●;
So is 8.5, the Fruſtum's Height, on D,
to .207, a *Segment*, on ●.

2. As 1, on B,
is to 128.18, the whole Content, on A;
So is .207, the Segment, on B,
to 26.58, the *Content of the Fruſtum*, on A.

PORB. XXVIII. Fig. 31.

Given a Spheroidal Cask whoſe Diameter { *Bung* A B 33 / *Head* C D 24.5 / *Length* E P 42 } *Inches.* — *To find the Content in Ale-Gallons.*

NOTE, That by Knowledge only of the *Diameters*, and *Length*, the *true Contents* of *all Casks* cannot be found by *one general Rule*, becauſe its

its poſſible for two Casks to have the *ſame Dimenſions*, and yet the *Space* between the *Bung* and *Head* may be more *Circular* in one than in the other, and conſequently more *capacious*: therefore,

1. On the *Flat* of the *Rule* find 8.5 the *Difference of Diameters*, on the Line of *Inches*, and againſt it on the Line marked *Fruſtum of a Spheroid* is 5.93, which added to 24.5, the *Head*, makes 30.43 a *Mean*.

As 18.95, the Gauge-point, on C,
is to 42, the Length, on D;
So is 30.43, the Mean Diameter, on C,
to 108.3, the *Content in Ale-Gallons*, on D.

2. Againſt 8.5, the *Difference of Diameters* on the *Inches* is 5.5 on the Line marked 2. *Form*, which added to 24.5 gives 30 a *Mean*.

As 18.95, the Gauge-point, on C,
is to 42, the Length, on D;
So is 30, the Mean Diameter, on C,
to 105.2, the *Content*, on D.

3. Againſt 8.5, the *Difference of Diameters* on the *Inches* is 5.04 on the Line marked 3. *Form* which added to 24.5 gives 29.54 a *Mean*:

As 18.95, the Gauge-point, on C,
is to 42, the Length, on D;
So is 29.54, the Mean Diameter, on C,
to 102.1, the *Content*, on D.

			Ale-Gall.	*Differ.*
The *Content* according to the	1	*Form* is	108.3	3.1
	2		105.2	3.1
	3		102.1	

Here you ſee the *Differences* are equal, ſo leſs room left for Error.

Hence

Hence I conclude that these are very ready, and genuine ways of *Cask Gauging*, and as exact as need be, considering their *uncertain Form.*

PROB. XXIX. Fig. 30.

			Inches.	
Given a	*Bung* . .	A B 29	*To find*	N O
Spheroidal	*Head* . .	C D 23	*the Diam. of*	
Cask whose	*Length*	E P 50	*the Liquors*	
Diameter	*Dry Part*	E R 13	*Surface.*	

AS 625, the Square of E K, the Semilength, on B,
is to 312, the Difference of the Squares of A B and C D, on A;
So is 144, the Square of R K the Distance from the Bung, on B,
to 71.88, the Difference of the Squares of A B and N O, on A.
Which Substracted from 841, the Square of the Bung, leaves 769.2, which found in the *first Radius* on D, against it on C is 27.74 the *Diameter* N O.

PROB.

PROB. XXX. Fig. 30.

Given a Spheroidal-Cask the Ax. Perpend. to the Horizon whose { *Length* EP 42 / *Dry part* ER 8 } *Inches.* / *Solidity* : : 108.3 *Gall.* } *To find the Vacuity, or Cont. of the Fruſt* CDNO

1. As EP 42, the Length, on A,
is to 100, the Radius, on the Line marked 1.S;
So is ER 8, the Dry Inches, on A,
to .171, a *Segment*, on 1.S.

2. As 1, on B,
is 108.3, the Cask's whole Content, on A;
So is .171, the Segment, on B,
to 18.5, *Cont. of the Fruſt.* CDNO, on A.

Which Taken from 108.3, the *whole Content*, the *Remaining Liquor*, or *Content of the Fruſtum* NOCD is 89.8 *Gallons*.

Or you may find the Remaining Liquor thus:

1. As EP 42, the Length, on A,
is to 100, the Radius, on the Line marked 1.S;
So is RP 34, the Wet Inches, on A,
to .829, a *Segment*, on 1.S.

2. As 1, on B,
is to 108.3, the whole Content, on A;
So is .829, the Segment, on B,
to 89.8, the *Gallons in the Cask*, on A.

If

If the Cask be taken in the Second Form.

1. As 42, the Length, on A,
is to 100, the Radius, on the Line marked 2.S;
So is 8, the Dry Inches, on A,
to .168, a *Segment*, on 2.S.

2. As 1, on B,
is to 105.2, the whole Content, on A;
So is .168, the Segment, on B,
to 17.7, the *Vacuity*, on A.

Which Substracted from 105.2 the whole Content, the Remaining Liquor is 87.5 Gallons.

If the Cask be taken in the Third Form.

1. As 42, the Length, on A,
is to 100, the Radius, on the Line marked 3.S;
So is 8, the Dry Inches, on A,
to .164, a *Segment*, on 3.S.

2. As 1, on B,
is to 102.1, the whole Content, on A;
So is .164, the Segment, on B,
to 16.7, the *Vacuity*, on A.

Which Taken from 102.1, the *whole Content* leaves 85.4 the *Gallons in the Cask*.

PROB.

PROB. XXXI. Fig. 31.

Given a Spheroidal-Cask the Ax. paral. to the Horizon, and the Liquors Surface cutting the Heads whose { *Bung Dia.* A B 33, *Dry Part* A G 8 } *Inches.* } *To find the Vacuity, or Content of the Frustum* D L M D.

Sol. Cont. 108.3 *Gall.*

1. As A B 33, the Bung Diameter, on D,
is to 100, the Radius, on the Line marked 1. L;
So is A G 8, the Dry Inches, on D,
to .173, a *Segment*, on 1. L.

2. As 1, on B,
is to 108.3, the whole Content, on A;
So is .173, the Segment, on B,
to 18.7, the *Vacuity*, on A.

Which Taken from 108.3, leaves 89.6 the *Gallons in it*, or *Content of the Frustum* L D D M.

Or you may find the Remaining Liquor thus:

1. As A B 33, the Bung Diameter, on D,
is to 100, the Radius, on the Line marked 1. L;
So is G B 25, the Wet Inches, on D,
to .827, a *Segment*, on 1. L.

2. As 1, on B,
is to 108.3, the whole Content, on A;
So is .827, the Segment, on B,
to 89.6, the *Remaining Liquor*, on A.

If the Cask be taken in the Second Form.

1. As 33, the Bung Diameter, on D,
is to 100, the Radius, on the Line marked 2.L;
So is 8, the Dry Inches, on D,
to .171, a *Segment*, on 2.L.

2. As 1, on B,
is to 105.2, the whole Content, on A;
So is .171, the Segment, on B,
to 18, the *Vacuity*, on A.

Which Deducted from 105.2 the *whole Content*, the *Remaining Liquor is* 87.2 *Gallons*.

If the Cask be taken in the Third Form.

1. As 33, the Bung Diameter, on D,
is to 100, the Radius, on the Line marked 3.L;
So is 8, the Dry Inches, on D,
to .169, a *Segment*, on 3.L.

2. As 1, on B,
is to 102.1, the whole Content, on A;
So is .169, the Segment, on B,
to 17.2, the *Vacuity*, on A.

Which Taken from 102.1 the *whole Content*, leaves 84.9 the *Gallons in the Cask*.

§. 4. Use

§. 4. *Use of the Rule in Gauging Ships.*

PROB. XXXII.

		Feet:	
Given a Ship whose	*Keel . . .*	80 *Long*	*To find how many Tuns She will carry.*
	Midsh. Beam	32 *Broad*	
	Hold . . .	14.1 *Deep*	

1. ASs 1, on B,
is to 80, the Keel's Length, on A;
So is 32, the Bredth of the Midship Beam, on B,
to 2560, a *fourth Number*, on A.

2. As 1, on B,
is to 2560, the fourth Number, on A;
So is 14.1, the Depth of the Hold, on B,
to 36096, a *seventh Number*, on A.

3. As 95, the *Divisor for Merchants Ships* on B,
is to 1, on A;
So is 36096, on B,
to 380, the *Ships Burden*, on A.

But for *Ships of War*, where there is an allowance for *Guns*, *Anchors*, *Cables*, *Masts*, *Sails*, &c. which are all a Burden but no Tunnage, the *Divisor is* 100.

This may serve to Guess at the *Tunnage* of a Ship, but there is a great deal more required to give the true measure.

The

The Way uſed by *Shipwrights*, as I received it from Mr. *Caſtell*, Maſter Builder at *Deptford*, is thus:

1. As 1, on B,
is to the *Len. of the Keel*, to the Rake, on A;
So is the *extreme Bredth* from Outſide to Outſide, on B,
to a *fourth Number*, on A.

2. As 1, on B,
is to the fourth Number, on A;
So is *Half the Bredth*, on B,
to a ſeventh Number, on A.

3. As 94, a conſtant Diviſor, on B,
is to 1, on A;
So is the ſeventh Number, on B,
to the *Ship's Burden*, on A.

PROB. XXXIII.

Given a Ship whoſe { *Keel* 44, *Beam* 17.6, *Hold* 7.76, *Burd.* 60 *Tuns* .... } *Feet* { *Long*, *Broad*, *Deep* } *To find the Dimenſions of another Ship of the ſame Mould whoſe Burden ſhall be* 360 *Tuns?*

1. AS 60, the Firſt Burden, on E,
is to 44, the Length of the Keel, on C;
So is 360, the Second Burden, on E,
to 80, the *Length of the Keel*, on C.

2. As

2. As 60, the Firſt Burden, on E,
is to 17.6, the Bredth of the Beam, on C;
So is 360, the Second Burden, on E,
to 32, the *Bredth of the Beam*, on C.

3. As 60, the Firſt Burden, on E,
is to 7.76, the Depth of the Hold, on C;
So is 360, the Second Burden, on E,
to 14.1, the *Depth of the Hold*, on C.

CHAP. VIII.

Uſe of the Rule in Geography.

GEography is an Art which teaches the true Notion of the Earth in relation to its Figure, Place, Magnitude, &c. *and is divided into two parts.* 1. *Univerſal.* 2. *Particular. The Firſt conſidereth the Earth in general, and explains all its Affections and Properties. The Second conſidereth the Conſtitution of the ſeveral Countries of the Earth.*

PROB.

PROB. I. Fig. 32.

Given two Places which differ only in Latitude: *To find their Distance.*

LET PQML represent the *First* or *Primary Meridian*, CBDL the *Equinoctial*, P the *North Pole*, M the *South Pole*, &c.

But Mr. *Richard Norwood* allows 69.548 *English Miles* to a *Degree*.

This *Problem* hath two Varieties.

1. *If both Places lie on the same side of the Equinoctial.*

Example. Let the Places be X and O { X, O } in { 51°.32', 33.00 } of North Latitude.

As 1, on B,
is to 60, the Miles in one Degree, on A;
So is 18, the Difference of Latitudes, on B,
to 1080, on A.

To which add 32 for the odd Minutes (*every Minute being accounted a Mile*) the Sum 1112 is their *Distance*.

2. *If two Places lie one on the North, and the other on the South side of the Equinoctial.*

Example. Let the Places be X and O { X, O } in { 51°.32' *North*, 34.00 *South* } Latitude.

As 1, on B,
is to 60, the Miles in a Degree, on A;
So is 85, the Sum of the Latitudes, on B,
to 5100, on A.

To which add 32 for the odd Minutes, the Sum 5132 is the *Distance.*

PROB. II. Fig. 32.

Given two Places which differ only in Longitude: } *To find their Distance.*

This *Problem* hath Two Varieties.

1. IF *both Places lye under the Equinoctial, and consequently differ only in Longitude.*

Example. Let the Places be B and D { B, D } in { 33°.10′, 137.10 } of *Longitude.*

As 1, on B,
is to 60, the Miles in a Degree, on A;
So is 104, the Difference of Longitudes, on B,
to 6240, the *Distance*, on A.

If the Difference of Longitudes exceed 180°. its *Complement* to 360° reduced into *Miles* is the *Distance.*

2. *If two Places lye not under the Equinoctial, but in some Paralliel of Latitude, between the Equinoctial, and one of the Poles.*

Example. Let A and Y be two Places whose { Latitude . . . . . 43°.00′, Difference of Longit. 43.15.

1. As

1. As 90°.00′, the Radius, on S,
is to A P 47°.00′, Comp. of the Latit. on SS;
So is A P Y 43.15, the Differ. of Longit. on S,
to A Y 30.05, the *Distance*, on SS.
Which converted into *Miles* gives 1805.

PROB. III. Fig. 33.

Given two Places which differ both in Latitude and Longitude: — *To find their Distance.*

This *Problem* hath Three Varieties.

1. *IF one Place lie under the Equinoctial, and the other towards either Pole.*

Examp. Let the Places be D and Q { D, Q } in { 00°.00′, 51.32 } of *Lat.* and in { 33°.10′, 20:00 } of *Long.*

As 90°.00′, the Radius, on S,
is to 76°.50′, the Complement of D E, the Difference of Longitudes, on SS;
So is 38°.28′. Compl. of E Q, the Lat. on S,
to 37°.19, Compl. of D Q, the *Dist.* on SS.
Therefore 52°.41′, is the *Distance*, which turned into *Miles*, gives 3161.

2. *If both Places lye on the same Side of the Equinoctial, but differ both in Latitude and Longitude.* Fig 34.

Examp. Let the Places be S and T { S, T } in { 51°.32′, 31.40 } of *Lat.* and in { 20°.00′, 66.00 } of Long.

1. As 90°.00′, the Radius, on SS,
is to A P 38°.28′, Compl. of one Lat. on T;
So is 44°.00′, the Complement of S P T the Difference of Longitude, on SS,
to P H 28°.55′, *a fourth Arch*, on T.

Which taken from the *Complement of the other Latitude* 58°.20′ leaves T H 29°.25′, *a fifth Arch*, then say:

2. As 61°.5′, the Compl. of the fourth Arch, on S,
is to 51°.32′, the first Latitude, on SS;
So is 60°,35′, the Compl. of the fifth Arch, on S,
to 51°.11′, the *Compl. of the Distance*, on SS.

Therefore A T the *Distance* is 38°.49′, that is 2328 *Miles*.

3. *If two Places lie one on the North, and the other on the South side of the Equinoctial, and in different Longitudes.* Fig. 34.

Examp. Let the Places be a and b { a, b } in { 43°.N, 35. S } *Lat.* and in { 15°.20′, 49.20 } of Long.

1. As 90°.00′, the Radius, on SS,
is to a P 47°.00′, the Complement of one Latitude, on T;
So is 56°.00′, the Complement of a P b, the Difference of Longitude, on SS,
to D K 41°.38, *a fourth Arch*, on T.

Which taken from P b 125 the Sum of R b 35° the lesser Latitude, and P R 90°. leaves K b 83°.22′, *a fifth Arch*, then say:

2. As

2. As 48°.22′, Compl. of the fourth Arch, on S,
is to 43°.00′, the first Latitude, on SS;
So is 16°.48, the Comple. of the fifth Arch, on S,
to 16°.03, the *Compl. of the Distance*, on SS.

Therefore a b 83°.57′, is the *Distance* which converted into *Miles* gives 5037.

These are all the *Varieties* that can happen in the position of the *Places* on the *Globe*, and tho there are divers other ways for finding the *Distance*, as by the *Globe*, by *Maps*, *Geometrically*, *&c.* yet this by Trigonometry is the most exact of all other, if the Longitude, and Latitude be truely given.

Note; if the *Longitude*, and *Latitude* of any *two fixed Stars*, or their *Declination* and *right Ascension* be given, by these *Problems* you may find their *Distance*.

CHAP. IX.

Use of the Rule in Astronomy.

Astronomy is an Art which teaches how to find the Distance, Magnitude, and Motions of the Planets, and Celestial Bodies for any Time past, present, or to come.

§. 1. *Of some Terms of Art used in Astronomy.* Fig. 35.

1. A *Sphere or Globe* is a Solid Figure contained under one *Round Superficies*, in the middle of which is a *Point or Center*, from whence all right Lines drawn to the *Superficies* or *Perifery* are equal.

2. The *Axis of the World* is a ſuppoſed *Strait Line* drawn from P the *North Pole*, thro the Center of the Earth to S the *South Pole*, about which the *Diurnal Motion* is performed from *Eaſt* to *Weſt*.

3. The *Horizon* is a *great Circle* 90 Degr. diſtant from the *Zenith* and *Nadir* as H ♎ R cutting all the *Azimuths* at right Angles, and dividing the *Sphere* into the Upper or *viſible*, and Lower or *inviſible Hemiſphere*, to which when the *Sun*, *Moon*, or *Stars* approach, they are ſaid to *Riſe* and *Set*.

4. The *Meridian* is a *great Circle* which cuts the *Horizon* at right Angles, and paſſeth thro' the *Zenith* and *Nadir* of the Place interſecting one another in the *Poles* of the World as PES, P c S, to which when the *Sun* comes 'tis *Noon*. The number of *Meridians* are as many as there can be imagined *Vertical Points* from *Weſt* to *Eaſt*; whereof *Coſmographers* have deſcribed 180.

5. The *Equinoctial* or *Equator* is a *great Circle* which cuts the *Meridian* at right-Angles, and divides the *Sphere* into two equal Parts, and is every way diſtant from the *Poles* of the *World* 90°.00', as E ♎ Q, ſo called becauſe when the *Sun* tranſits it, which is when he enters ♈ or ♎ he makes the *Days* and *Nights equal* in all Places.

6. The *Zodiack* or *Signifer* is a *great Circle* having 7°. 00' of *Latitude* on either ſide of the *Ecliptick*, and encompaſſes the *Sphere* obliquely like a *Belt or Girdle*.

The *Ecliptick* repreſented by ♋ ♎ ♑ is cut by the *Equinoctial* into two equal Parts in the Points ♈ and ♎, in this the *Planets* move, and from hence the *Latitudes* of the *Planets*, and *Fixed Stars* are meaſured, either to the *North* or *South*, from which no *Star* can be diſtant above 23°.30'. This

Circle

Circle regulates the *Years*, *Months*, and *Seasons*, and is divided into 12 Parts called *Signs*, viz.

Aries, *Taurus*, *Gemini*, *Cancer*, *Leo*, *Virgo*,
♈ ♉ ♊ ♋ ♌ ♍
Libra, *Scorpio*, *Sagittary*, *Capricorn*, *Aquary*, *Pisces*.
♎ ♏ ♐ ♑ ♒ ♓

each of these *Signs* is divided into 30 *Degr.* every *Degr.* into 60 *Minutes*, &c.

7. *Longitude* of a *Place* is an Arch of the *Equinoctial* contained between the *First Meridian* (or *Merid.* of the Place where the *Longitude* is assigned to begin) and the *Meridian* of any other Place, counted always from *West* to *East*.

Or tis the Distance of any Place counted on the *Equinoctial*, from some *Primary Meridian* as the *Azores*, *Teneriff*, *London*, *Paris*, &c.

8. *Difference* of *Longitude* is an Arch of the *Equinoctial* comprehended between the *Meridians* of any two Places.

9. *Latitude of a Place* is an Arch of the *Meridian* contained between the *Zenith* of the *Place*, or *Height of the Pole* and the *Equinoctial*; Or between the *Pole* and the *Horizon*.

10. *Difference of Latitude*, is an Arch of the *Meridian* contained between any two given *Latitudes*.

11. The *Colures* are two *great Circles* dividing the *Ecliptick*, and the *Equinoctial* into four equal Parts:

The *Equinoctial Colure* passeth thro P S the *Poles* of the *World*, and Cuts the *Ecliptick* in the Points ♈ and ♎ as P ♎ S.

The *Solstial Colure* passeth thro P S the *Poles* of the *World*, and Cuts the *Ecliptick* in the Points ♋ and ♑, as ♋ ♎ ♑.

12. The *Tropicks* are two *small Circles* Parallel to the *Equinoctial*, and distant from it 23.30 limitting the *Sun's greatest Declination*. The *Northern* is that of ♋, which the *Sun* touches when he enters the first Point of ♋ as ♋ a D, making the *longest Day* and *shortest Night* in our *Hemisphere*.

The *Southern* is that of ♑ which the *Sun* touches when he enters the first Point of ♑ as B b ♑, making the *shortest Day*, and *longest Night* in our *Hemisphere*.

13. The *Polar Circles* are two *small Circles* Parallel to the *Equinoctial*, and distant from it 66°.30', and from the *Poles* of the *World* 23°.30'; That which encloseth the *North Pole* is the *Artick Circle* as G d I, and is always *visible* in *these Regions*, in which those Stars are placed that neither *Rise* nor *Set*, but are always above the *Horizon*.

That which encloseth the *South-Pole* is the *Antartick Circle*, as K d M, and is always under the Earth with us, and those Stars which are placed in it, are always *invisible* in our *Horizon*.

14. The *Zenith* and *Nadir* are two *Points* directly over and under us, as Z and N.

15. *Hour Circles* are *great Circles* which pass from the North to the *South Pole*, and cut the *Equinoctial* into 24 equal parts.

16. *Azimuth*, or *Vertical Circles* are Arches of the *Horizon*, contained between the *Meridian*, and the *Vertical Lines* passing by the *Sun*, that of *East* and *West* being called by the *Ptolomaicks* the *prime Vertical*.

17. *Almicanters* or *Circles of Altitude* are *small Circles* drawn thro every Degree of the *Azimuths* Parallel to the *Horizon*, and shew how far any Point of the Heavens is distant from the *Horizon* as B a F.

18. De-

18. *Declination* of the *Sun* or any *Star* is its *Distance* from the *Equinoctial* and as he declines from thence towards either *Pole*, so his *Declination* is denominated either *North*, or *South*.

19. *Latitude* of a *Star* is an Arch of a *Circle* contained between the *Star*, and the *Ecliptick*.

20. *Longitude of a Star* is an Arch of the *Ecliptick* comprehended between the *Star's place*, and the beginning of ♈ according to the Succession of Signs.

21. *Altitude* of the *Sun*, or any *Star* is its Distance from the *Horizon* counted on the *Meridian*.

22. *Right Ascension* is an Arch of the *Equinoctial* (counted from the beginning of ♈) which comes to the *Meridian* with the *Sun*, *Moon*, or *Stars*, or with any part of the *Ecliptick*.

23. *Oblique-Ascension* is an Arch of the *Equinoctial* contained between the beginning of ♈, and that part of the *Equinoctial* which rises with a *Star*, or with any part of the *Ecliptick* in an *oblique Sphere*.

Oblique Descension is that part of the *Ecliptick* which Sets with it.

24. *Ascensional Difference* is an Arch of the *Equinoctial*, contained between the *Right* and *Oblique Ascension* of any *Point* in the *Ecliptick*.

25. *Amplitude* of the *Sun*, or any *Star*, is the *Difference* of its *Rising* or *Setting* from the true *East* or *West points* of the *Horizon* towards the *North* or *South*.

26. *Parallax* is the Difference between the *true* and *apparent places* of the *Sun* or any *Star*.

§. 2. *Of Divers useful Problems in Astronomy.*

PROB. I. Fig. 3.

Given the Sun's { *Distance from* ♈ A C 30°.00′ ; *Greatest Declination* A 23.30 } *To find* B C *his present Declination.*

As S 90°.00′, the Radius, on S,
is to A C 30°.00′, the Distance from ♈, &c. on SS;
So is A 23°.30′, the Greatest Declination, on S,
to B C 11°.30′, the *present Declination*. on SS.

If a Planet be in { ♈ ♎ his *Longitude* ; ♉ ♍ 30° added } to his ; ♊ ♐ 60 added } *Longitude* ; ♋ ♑ the Compl of his *Long.* to 90° ; ♌ ♒ Subs. } the *Lon.* { 60° } the Re ; ♍ ♓ Subs. } out of { 30 } maind. } is the Distance from the next *Equinoctial Point* ♈ or ♎.

PROB. II. Fig. 3.

Given the Sun's { *Present Declinat.* B C 11°.30′ ; *Greatest Declinat.* A 23.30 } *To find his Place in the Ecliptick.*

As S A 23°.30′, the Greatest Declinat. on S,
is to B C 11°.30′, his Present Declin, on SS;
So is 90°.00′, the Radius, on S,
to A C 30°.00′, his *Distan. from* ♈, &c. on SS.

If

If the Planet be in ♈ ♉ ♊ ♍ ♒ ♐ / ♋ ♌ ♍ ♎ ♏ ♑ the *Distance* found is to be counted from ♈ / ♎

PROB. III. Fig. 3.

Given the Sun's *Distance from* ♈ AC 30°.00′, *Greatest Declination* A 23.30 — *To find* AB *his Right Ascension.*

AS 90°.00′, the Radius, on SS,
is to AC 30°.00′, his Distance from ♈, &c. on T;
So is 66°.30′, the Complement of A the Greatest Declination, on SS,
to AB 27°.54′, his *Right Ascen.* from ♈, on T.

But if the *Sun* be in ♋ ♌ ♍ 180° less / ♎ ♏ ♑ 180 more / ♍ ♒ ♐ 360 less, the Arch found is his *Right Ascension.*

PROB. IV. Fig. 3.

Given the Sun's *Right Ascension* AB 27°.54′, *Greatest Declinat.* A 23.30 — *To find his Place in the Ecliptick.*

AS 66°.30′, the Complement of A the Greatest Declination, on SS,
is to AB 27°.54′. Sun's Right Ascension, on T;
So is 90°.00′, the Radius, on SS.
to AC, 30°.00, the *Dist. from* ♈, &c. on T.

PROB

PROB. V. Fig. 3.

Given the Sun's { *Present Declination* B C 11°.30′ ; *Greatest Declination* A 23.30 } *To find* A B *his right Ascension.*

AS A, the Greatest Declination, on T,
is to 90°.00′, the Radius, on SS;
So is B C 11°30′, Present Declination, on T,
to A B 27°.54′, the *Right Ascension* SS.

PROB. VI. Fig. 3.

Given { B C *the Sun's Declination* 11°.30′ ; A *the Compl. of Latitude* 38.28 } *To find the Ascensional Difference.*

AS A, 38°.28′, the Compl. of the Latit. on T,
is to 90°.00′ the Radius, on SS;
So is B C 11°.30′, the Declination, on T.
to A B 14°.50′, *Ascension. Difference*, on SS.

Which converted into Time by allowing for every *Degree* 4 *Min.* and for every 15 *Min.* one *Minute*, it will amount to 59 *Min.* of an *Hour.*

When the *Declination* is { *Nor.* / *Sou.* } the { *Ascension.* / *Difference* } { added to / taken from } 6 *Hours* gives the *Time* of *Sun* { *Setting.* / *Rising.* }

And

And double the { *Setting* / *Rising* } is the *Length* of the .. { *Day* / *Night*

	h ′
Semi-diurnal Arch of a *Right Sphere* . . .	6.00
Ascensional Difference in *Time* add	0.59
Semi-diurnal Arch, or *Time* of *Sun Setting*	6.59
Which doubled is the *Length* of the *Day* . .	13.58
And its Compl. to 24 Hours is the *Length* of the *Night*	10.02
The half of which is the *Time* of *Sun rising*	5.01

When the *Declination* is { *Nor.* Subs. / *Sou.* add } the *Ascensional Difference* { from / to } the *Right Ascen.* and you have the *Oblique* { *Ascen.* / *Descen.* }
{ *Nor.* add / *Sou.* Subs. } { to / from }

PROB. VII. Fig. 3.

Given the { B C *Sun's Declination* 11°.30′ / A *Comp. of the Latitude* 38.28 } *to find* A B *the Sun's Amplitude.*

As A S 38°.28′, Compl. of the Latitude, on S.
is to 90°.00′, the Radius, on SS;
So is B C 11°.30′, the Declination, on S,
to A B 18°.41′, the *Amplitude*, on SS.

If the *Declination* be { *North* / *South* } the *Amplitude* is { *North* / *South*.

PROB.

PROB. VIII. Fig. 4.

Given the { *Sun's Distance from* ♈ 30°.00′ ; *Latitude of the Place* 51.32 } *To find the Sun's Amplitude.*

As C D A 38°.28′, the Complement of the Latitude, on S,
is to A B 30°.00′, the Distance from ♈, on SS,
So is C D 23°.30′, the greatest Declination, on S;
to C D 18°.41′, the *Amplitude*, on SS.

PROB. IX.

Given the { *Sun's Declination* . . 11°.30′ ; *Latitude of the Place* 51.32 } *To find the Angle of Position at the Time of Sun Rising.*

As S 78°.30′, the Complement of the Declination, on S,
is to 90°.00′, the Radius, on S,
So is 51° 32′, the Latitude, on S,
to 53°.2′, *Angle of the Sun's Position*, on SS.

PROB.

PROB. X.

Given the { *Sun's Declination* . . 11°.30′ / *Latitude of the Place* 51.32 } *To find when the Sun will be due East or Weſt.*

AS 51°.32′, the Latitude at the end of the Line, on T,
is to 90°.00′, the Radius, on SS;
So is 11°.30′, the Declination, on T,
to 9°.18′, the *Hour from* G I, on SS.
Which converted into Time is 37 Minutes.

And ſo long { *after* / *before* } { *Six* in the } { *Morning* / *Evening* } the *Sun* will be due { *East*: / *Weſt*. }

PROB. XI.

Given the { *Sun's Declination* . . 11°.30′ / *Latitude of the Place* 51.32 } *To find the Sun's Altitude when he is due East or Weſt.*

AS 51°.32′, the Latitude, on S,
is to 90°.00′, the Radius, on SS;
So is 11°.30′, the Declination, on S,
to 14°.45′, the *Altitude*, on SS.
Uſually called the *Prime Vertical*, or *Azimuth* of *East* and *Weſt*.

PROB.

PROB. XII.

Given the { *Sun's Distance from* ♈ 30°.00′ ; *Latitude of the Place* 51,32 } *To find the Sun's Altitude when due East or West.*

As 51°.32, the Latitude, on S,
is to 30°.00, Distance from ♈, &c. on SS;
So is 23°.30′, the Greatest Declination, on S,
to 14°.45′, the *Altitude*, on SS.

PROB. XIII.

Given the { *Sun's Declination* . . 11°.30′ ; *Latitude of the Place* 51.32 } *To find the Sun's Altit. at the Hour of* 6.

As 90°.00′, the Radius, on S,
is to 51°.32′, the Latitude, on SS;
So is 11°.30′, the Declination, on S,
to 8°.59′, the *Altitude at* VI, on SS.

PROB

PROB. XIV.

Given the { *Time from Noon* 2h.00′ ; *Latitude* . . . 51°.32′ } *To find the Sun's Altitude when he is in the Equinoctial.*

As 90°.00′, the Radius, on S,
is to 38°.28′, the Complement of the Latitude, on SS;
So is 60°.00′, the *Complement of the Distance from the Meridian*, on S,
to 32°.37′, the *Altitude*, on SS.

On the 10th. of *March* at 10 a Clock in the Morning, and 2 in the Afternoon.

PROB. XV.

Given the { *Sun's Declination* . . 11°.30′ ; *Latitude of the Place* 51.32 } *To find the Sun's Azimuth at Six a Clock.*

As 90°.00, the Radius, on SS,
is to 11°.30′, the Declination, on T;
So is 38°.28′, Compl. of the Latitude, on SS,
to 82°.47, the *Azimuth* from the *North part of the Meridian*, on T.

And 97°.13′ its Complement to 180°.00′, is the *Azimuth* from the *South Meridian*.

PROB.

PROB. XVI.

Given the { *Sun's Altitude when due East or West* } 14°.45′ } *To find when he will be due East or West.*
{ *Latitude of the Place* . . 51.32 }

As 90°.00′, the Radius, on S,
is to 14°.45′, the Altitude, on T;
So is 38°.28′, the Compl. of the Latitude, on S,
to 9°.18′, the *Hour from* VI, on T.
Which converted into Time, gives 37 Minutes.

So that the *Sun* will be due { *East* / *West* } at { 37′ / 23 } past { VI / V } in the { *Morn.* / *Even.* }

PROB. XVII.

Given the Sun's { *Distance from* ♈ 30°.00′ / *Greatest Declinat.* 23.30 } *To find the Angle of the Meridian and Ecliptick.*

As 90°.00′, the Radius, on SS,
is to 23°.30′, Greatest Declination, on T;
So is 60°.00′, the Compl. of the Distance
from ♈, on SS,
to 20°.38′, the *Complement of the Meridian Angle*, on T.
Therefore the *Angle* is 69°.22′.

PROB.

PROB. XVIII.

Given the Sun's { *Right Aſcenſion* 27°.54′ / *Greateſt Declination* 23.30 } *To find the Angle of the Meridian and Ecliptick.*

As 90°.00′, the Radius, on S,
is to 62°.6′, the Complement of the Right Aſcenſion, on SS;
So is 23°.30′, the Greateſt Declination, on S,
to 20°.38′, the *Complement of the Meridian Angle*, on SS.
Therefore the Angle is 69°.22′.

PROB. XIX.

Given the Sun's { *Declination* 11°.30′ / *Amplitude* 18.41 } *To find the Latitude.*

As 18°.41′, the Amplitude, on S,
is to 90°.00′, the Radius, on SS;
So is 11°.30′, the Declination, on S,
to 38°.28′, *Compl. of the Latitude*, on SS,
Therefore the *Latitude* is 51°.32′.

PROB.

PROB. XX.

Given the Sun's { *Amplitude* . . 18°.41′ / *Time of Rising* 5ʰ.04′ } *To find his Declination.*

As 75°.15′, the Time of Sun Rising in Degrees, on S,
is to 90°.00′, the Radius, on SS;
So is 71°.19′, Compl. of the Altitude, on S,
to 78°.30′, *Compl. of the Declination*, on SS.
Therefore the *Declination* is 11°.30.

PROB. XXI.

Given { *The Sun's Amplitude* 18°.41′ / *Latitude of the Place* 51.32 } *To find the Sun's Declination.*

As 90°.00′, the Radius, on S,
is to 38°.28′, Compl. of the Latit. on SS;
So is 18°.41′, the Amplitude, on S,
to 11°.30′, the *Declination*, on SS.

PROB.

PROB. XXII.

Given the { Sun's { Altitude 25°.56' / Declination 11.30 } / Time from Noon 4h.04' } To find the Sun's Azimuth.

As 64°.04', Compl. of the Altitude, on S, is to 61°.00', the Time from Noon, on SS; So is 78°.30', Compl. of the Declination, on S, to 72°.22', the *Azimuth* from the *South part of the Meridian*, on SS.

Whose Complement to 180°.00', is 107°.38', is the *Azimuth* from the North.

PROB. XXIII.

Given the Sun's { Declination 11°.30' / Altitude . . 25.56 / Azimuth . . 72.22 } To find the Hour of the Day.

As 78°.30', Compl of the Declination, on S, is to 64°.04', Compl. of the Altit. on SS; So is 72°.22', the Azimuth, on S, to 61°.00', the *Horary distance* from the *Meridian*.

Which converted into Time gives 4 Hours 4 Min: And this taken from 12 Hours leaves 7h.56', the Time of the Day.

Equi-

Equinoctial Degrees, and Minutes answerable to the Hours, and Minutes of Time.

Hour	Deg.	Min.	D. M.	Min.	D. M.
1	15	1	0.15	31	7.45
2	30	2	0.30	32	8.00
3	45	3	0.45	33	8.15
4	60	4	1.00	34	8.30
		5	1.15	35	8.45
5	75	6	1.30	36	9.00
6	90	7	1.45	37	9.15
7	105	8	2.00	38	9.30
8	120	9	2.15	39	9.45
		10	2.30	40	10.00
9	135	11	2.45	41	10.15
10	150	12	3.00	42	10.30
11	165	13	3.15	43	10.45
12	180	14	3.30	44	11.00
		15	3.45	45	11.15
13	195	16	4.00	46	11.30
14	210	17	4.15	47	11.45
15	225	18	4.30	48	12.00
16	240	19	4.45	49	12.15
		20	5.00	50	12.30
17	255	21	5.15	51	12.45
18	270	22	5.30	52	13.00
19	285	23	5.45	53	13.15
20	300	24	6.00	54	13.30
		25	6.15	55	13.45
21	315	26	6.30	56	14.00
22	330	27	6.45	57	14.15
23	345	28	7.00	58	14.30
24	360	29	7.15	59	14.45
		30	7.30	60	15.00
		Sec.	M. S.	Sec.	M. S.

Hours and Minutes of Time answerable to the Equinoctial Degrees, and Minutes.

Deg.	H. M.	Deg.	H. M.	Deg.	H. M.
1	0.04	31	2.04	70	4.40
2	0.08	32	2.08	80	5.20
3	0.12	33	2.12	90	6.00
4	0.16	34	2.16	100	6.40
5	0.20	35	2.20	110	7.20
6	0.24	36	2.24	120	8.00
7	0.28	37	2.28	130	8.40
8	0.32	38	2.32	140	9.20
9	0.36	39	2.36	150	10.00
10	0.40	40	2.40	160	10.40
11	0.44	41	2.44	170	11.20
12	0.48	42	2.48	180	12.00
13	0.52	43	2.52	190	12.40
14	0.56	44	2.56	200	13.20
15	1.00	45	3.00	210	14.00
16	1.04	46	3.04	220	14.40
17	1.08	47	3.08	230	15.20
18	1.12	48	3.12	240	16.00
19	1.16	49	3.16	250	16.40
20	1.20	50	3.20	260	17.20
21	1.24	51	3.24	270	18.00
22	1.28	52	3.28	280	18.40
23	1.32	53	3.32	290	19.20
24	1.36	54	3.36	300	20.00
25	1.40	55	3.40	310	20.40
26	1.44	56	3.44	320	21.20
27	1.48	57	3.48	330	22.00
28	1.52	58	3.52	340	22.40
29	1.56	59	3.56	350	23.20
30	2.00	60	4.00	360	24.00
Min.	M. S.	Min.	M. S.	Min.	M. S.

PROB. XXIV.

Given the { *Sun's Altitude* . . . . 25°.56′ ; *Time from Noon* . . . 4ʰ.04′ ; *Latitude of the Place* 51°.32′ } *To find the Angle of the Sun's Position at that Time.*

As 64°.04′, the Compl. of the Altitude, on S,
is to 61°.00′, the Horary Distance from the Meridian, on SS;
So is 38°.28′, the Compl. of the Latitude, on S,
to 37°.14′, *Angle of the Sun's Position*, on SS.

PROB. XXV.

Given the Sun's { *Declination* . . . . 11°.30′ ; *Azimuth* . . . . . 72.22 ; *Angle of Position* 37.14 } *To find the Latitude:*

As 72°.22′, the Azimuth, on S,
is to 78°.30′, the Complement of the Declination, on SS;
So is 37°.14′, the Angle of Position, on S,
to 38°.28′, the *Compl. of the Latitude*, on SS.
Therefore the *Latitude* is 51°.32′.

PROB.

PROB. XXVI.

Given the Sun's or Stars { *Declination* . . . . . 11°.30′ ; *Latitude of the Place* 51.32 ; *Time from Noon* . . 2ʰ.00′ } *To find the Altitude at that Time.*

1. As 90°.00′. the Radius, on SS,
is to 38°.28′, the Complement of the Latitude, on T;
So is 60°.00′, the Complement of the Time from Noon, on SS,
to 34°.32′, a *fourth Arch*, on T.

Which taken from 78°.30′, (the Sun's Distance from the Pole) because the *Declination* is *North*, leaves 43°.58′, a *fifth Arch*, then say:

2. As 55°.28′, the Complement of the fourth, Arch, on S,
is to 46°.02′, the Complement of the fifth Arch, on SS;
So is 51°.32′, the Latitude, on S,
to 43°.18′, the *Altitude at* 10 *a Clock*, on SS.

Note, that 90 Degrees { *less* / *more* } the *Declination* if { *North* / *South* } is the *Distance* from the next *Pole*.

Or 34°.32′, the *fourth Arch*, taken from 101°.30′. the Sun's distance from the Pole when the *Declination* is *South*, leaves 66°.58′, a *fifth Arch*, then say:

As 55°.28, the Compl. of the fourth Arch, on S,
is to 23°.02, Compl. of the fifth Arch, on SS;
So is 51°.32′, the Latitude, on S,
to 21°.49′, the *Altitude*, on SS.

PROB. XXVII.

Given the	*Sun's*	*Declination*	11°.30′	*To find the Hour of the Day.*
		Altitude	25.56	
	Latit. of the Place		51.32	

By *Prob.* XXVI the Distance from the Pole		78°.30′
The Compl. of the	Altitude	64.04
	Latitude	38.28
The	Sum	181.02
	Half Sum . . .	90.31
The Complement of the Altude Substract		64.04
The Difference		26.27 which reserve.

1. As 90°.00′, the Radius, on S,
is to 38°.28′, Compl. of the Latitude, on SS,
So is 78°.30′, the Distance from the Pole, on S,
to 37°.34′, a *fourth Arch*, on SS.

2. As 37°.34′, the fourth Arch, on S.
is to 89°.29′, the Complement of the Semi-Sum to 180°, on SS;
So is 26°.27′, the reserved Difference, on S,
to 46°.57′, a *seventh Arch*, on SS.

Then half the Distance between 46°.57′, and 90°. will fall on 58°.44′, whose Complement to 90°.00′ is 31°.16′, which doubled is 62°.32′ equal to 4h.10′, the *Time from Noon*.

PROB.

PROB. XXVIII.

Given the { *Sun's* { *Declinat.* 11°.30′ / *Altitude* 25.56 } / *Lat. of the Place* 51.32 } *To find the Sun's Azimuth.*

By *Prob.* XXVI. the Distance from the Pole		78°.30′
The Complement of the	Altitude	64.04
	Latitude	38.28
The Sum		181.02
The Half Sum		90.31
The Distance from the Pole Substract		78.30
The Difference		12 01 which reserve.

1. As 90°.00′, the Radius, on S,
is to 38°.28′, Compl. of the Latitude, on SS;
So is 64°.04′, the Compl. of the Altitude, on S,
to 34°.01, a *fourth Arch*, on SS.

2. As is 34°.01′, the fourth Arch, on S,
is to 89°.29′, the Complement of the Semi-Sum to 180°, on SS;
So is 12°.01′, the reserved Difference, on S,
to 21°.51, a *seventh Arch*, on SS.

Then divide the Space on S between 21°.51′ and 90° into two equal parts, and the Compass Point will fall on 37°.36′ a *Mean*, whose Complement to 90°.00′ is 52°.24′, which doubled is 104°.48′ the *Azimuth* from the *South part* of the *Meridian*,

and 85°.12′ its Complement to 180°.00′ is the *Azimuth* from the *North*.

PROB. XXIX.

Given a Star whose { *Long.* ♉ 25°.18′ / *Latitude* 4.00 } *To find his Declination.*

1. As 90°.00′, the Radius, on SS,
is to 23°.30′, the Greatest Declin. on ♈;
So is 55°.18′, the Longitude, on SS,
to 19°.40′, a *fourth Arch*, on ♈.
Which taken from 86°.00′, the *Complement of the Latitude*, leaves 66°.20′, a *fifth Arch*, then say:
2. As 70°.20′, Compl. of the fourth Arch, on S,
is to 66°.30′, Compl. of the Declination, on SS;
So is 23°.40′, Compl. of the fifth Arch, on S,
to 23°.01′ the *Declination*, on SS.

PROB. XXX.

Given a Star whose { *Longitude* ♉ 25°.18′ / *Latitude* . . . 4.00 / *Declination* 23.01 } *To find his Right Ascension.*

As 69°.22′, Compl. of the Declination, on S,
is to 34°.42′, Compl. of the Long. on SS;
So is 86°.00′, Compl. of the Latitude, on S,
to 38°.5′, *Compl. of the Right Ascension*, on SS.
Therefore his *Right Ascension is* 51°.55′.

PROB.

PROB. XXXI.

Given a Star whose { *Declination* 23°.01′ / *Right Ascension* 51.55 / *Latitude* . . . 4.00 } *To find the Longitude.*

As 86°.00′, Compl. of the Latitude, on S,
is to 38°.5′, the Complement of the Right Ascension, on SS;
So is 66°.59′, Compl. of the Declination, on S,
to 34°.42′, the *Compl. of the Long.* on SS.
Therefore 55°.18′, *viz.* 825°.18′ is the *Longitude*

PROB. XXXII.

Given a Star whose { *Longitude* ♉ 25°.18′ / *Declination* . . 23.1 } *To find the Latitude.*

1. As 90°.00′, the Radius, on SS,
is to 23°.30′ the Greatest Declin. on T;
So is 55°.18′, the Longitude, on SS,
to 19°.40′, a *fourth Arch*, on T.

2. As 66°.30′, Compl. of the greatest Declin. on S,
is to 70° 22′, Compl of the fourth Arch, on SS;
So is 23°.1′, the given Declination, on S,
to 23°.40′, a *seventh Arch*, on SS.
From which take 19°.40′ the *fourth Arch* Rests
4°.00′ the *Latitude*.

PROB. XXXIII.

Given a Star whose { *Longitude* ♉ 25°.18′ / *Right Aſcenſion* 51.55 / *Latitude* . . . 4.00 } *To find the Declination.*

As S 38°.5′, the Complement of the Right Aſcenſion, on S,
is to 86°.00′, Compl. of the Latitude, on SS;
So is 34°.42′, the Compl. of the Longitude, on S,
to 66°.59′, *Compl. of the Declination*, on SS.
Therefore the *Declination* is 23°.1′. *North.*

CHAP. X.

Uſe of the Rule in Navigation.

Navigation is an Art which teaches how by the beſt Way, and in the ſhorteſt Time, a ſufficient Ship may be directed thro' the Ocean from one Part to another in any part of the World:

And is diſtinguiſhed into *three Sorts*, viz. { *Plain* / *Mercator's* / *Circular* } *Sailing.*

In this Art the *Mariner* hath three helps, *viz.* the { *Compaſs.* / *Log-Line.* / *Latitude.* }

By

By these, and the help of *Trigonometry*, he knows all that is necessary for keeping his Account, *viz.* *where he is*, *how far he hath sailed*, and consequently *how far he hath to Sail*, and *what Course he must Steer*.

SECT. I.

Of Plain Sailing.

PLain Sailing Shews all the Varieties of a Ship's motion on a Plain where all the Meridians are made Parallel, the Parallels at right Angles with the Meridians, and the Degrees of each Parallel equal to those of the Equinoctial.

1. *Latitude* is the *Distance* of a Ship, or Place from the *Equinoctial* either *North* or *South*, and is counted on the *Meridian*.

2. *Longitude*, is the *Distance* of a Ship, or Place *East* or *West*, from another counted in *Degr.* &c. but if in *Miles*, or *Leagues*, 'tis called *Departure*, *Easting* or *Westing*, *Difference of Longitude*, &c.

3. The Course or *Rumb* is that *Point* of the *Compass*, on which the *Ship* is Steered from one Place to another.

I should next proceed to the Solution of the *several Cases*, but I shall first premise these IX. *General Rules*.

RULE I.

Given the Latitudes of any two Places: } *To find Their Difference.*

IF the *Latitudes* be of { the same / *Different* } *Denomination* their { *Differ.* / *Sum* } is the *Difference.*

RULE II.

Given the Latitudes of any two Places: } *To find whether you must Sail Northward, or Southward.*

1. THE *Course* from { Nor. / Sou. } *Latitude* to { Sou. / Nor. } is { *Southw.* / *Northw.* }

2. The *Course* from a { Greater / Lesser } *Nor. Lat.* to a { Lesser / Greater } is { *Southwar.* / *Northwar.* }

3. The *Course* from a { Greater / Lesser } *Sou. Lat.* to a { Lesser / Greater } is { *Northwar.* / *Southwar.* }

RULE

RULE III.

The Ship in North Latitude.

1. If the *Course* be { Northw. / Southw. } the *Diff.* of *Lat.* { added to / taken from } the *Lat.* she sailed from gives the { *Lat.* / *Nor.* }

2. If the *Course* be *Southward*, and the *Difference* of *Latitudes* exceeds the *Latitude* the *Ship* sailed from, Substract the said *Latitude* from the *Departure*, and the *Remainder* is the *Latitude South*, and by consequence he hath croft the *Equinoctial*.

RULE IV.

The Ship in South Latitude.

1. If the *Course* be { Southw. / Northw. } the *Diff.* of *Lat.* { added to / taken from } the *Lat.* she sailed from gives the { *Lat.* / *Sout.* }

2. If the *Course* be *Northward*, and the *Difference* of *Latitudes* exceeds the *Latitude* the Ship sailed from, Substract the said *Lat.* from the *Departure*, and the *Remainder* is the *Latitude North*, and consequently she hath croft the *Equinoctial*.

RULE V.

Given the Longitudes of any two Places distinguished by East and West: } *To find the Departure, or Difference of Longitudes.*

IF the *Longitudes* be of { The same / Different } *Denomination*, their { *Differ.* / *Sum* } is the *Departure* in Degrees and Minutes.

If the *Sum* exceeds 180°. its Complement to 360°. is the *Difference* of *Longitudes*; If it exceed 360°. Substract 360°. from it.

RULE VI.

Given the Longitudes of any two Places: } *To find whether you must Sail Eastward or Westward.*

1. The *Course* from { East / West } *Longitude* to { West / East } is { *Westw.* / *Eastw.* }

2. The *Course* from a { Greater / Lesser } *East Long.* to a { Lesser / Greater } is { *Westward* / *Eastwar.* }

3. The *Course* from a { Greater / Lesser } *West Long.* to a { Lesser / Greater } is { *Eastward* / *Westward.* }

RULE

RULE VII.

The Ship in East Longitude.

1. If the *Course* be { Eastw. / Westw. } the *Depart.* { added to / Subst. from } the *Long.* she sailed from gives the *Longit.* { *East.* / *west.*

If the Sum exceeds 180°, its Complement to 360° is the *Longitude.*

2. If the Course be *westward*, and the *Departure* exceeds the *Longitude* the *Ship* sailed from, Substract the said *Longitude* from the *Departure*, and the *Remainder* is the *Longitude East*, and consequently she hath croſt the *first Meridian.*

RULE VIII.

The Ship in West Longitude.

1. If the *Course* be { Westw. / Eastw. } the *Depart.* { added to / Subst. from } the *Long.* she sailed from gives the *Longit.* { *west.* / *East.*

If the Sum exceeds 180°, its Complement to 360° is the *Longitude.*

2. If the Course be *Eastward*, and the *Departure* exceeds the *Longitude* the *Ship* sailed from, Substract the said *Longitude* from the *Departure*, and the Remainder is the *Longitude west*, and consequently she hath croſt the *first Meridian.*

RULE

RULE IX.

Given the Course, and Quarter of the Compass sailed on: } *To find the Rumb.*

If the *Course* be { Greater / Lesser } than the next *whole Point* you have sailed to the { *Eastward*, or *Westward* / *Northw.* or *Southward* } of that *Point.*

PROB. I. Fig. 37.

Given the Course, and Distance run: } *To find the Longit. and Latitude.*

A *Ship from* { 50°.00′ *North Lat.* / 70.00 *East Long.* } *Sails NE by E,* 390 *Miles.*

1. As 90°.00′, the Radius, on S,
is to A C, the Distance run 390 Miles, on D;
So is A, the Course 56°.15′, on S,
to B C the *Departure* 324 *Miles*, on D.
Which reduced gives 5°.24′.
Therefore by 1. *Rule* VII, the *Ship* is in 75°.24′ *East Longitude.*

2. As the Radius, 90°.00′, on S,
is to A C, the Distance run 390 Miles, on D;
So is C, the Compl. of the Course 33°.45′, on S,
to A B, *Differ. of Latitude* 210 *Miles*, on D.
Which reduced gives 3°.36′.

There-

Therefore by 1. *Rule* III. the *Ship* is in 53°.36′ *North Latitude.*

Note, that both these may be found by the *Dead Reckoning* or *estimate Distance* by the *Log*, but are not to be depended on, by reason of many Accidents, as *high Winds*, *rough Seas*, *Currents*, &c. therefore as soon as the *Sun*, or *Stars appear*, observe the *Latitude*, and take the Difference between it and the *Latitude* you came from, and with this *true Difference*, and the *Course* find the *Departure*, and *Distance*, by *Prob.* II.

Angles

Angles each Rumb, or Point of the Compass makes with the Meridian

Point.	North	South	Deg. M.	South	North
			2 49		
			5 38		
			8 26		
1	N by E	S by E	11 15	S by W	N by W
			14 4		
			16 53		
			19 41		
2	NNE	SSE	22 30	SSW	NNW
			25 19		
			28 8		
			30 56		
3	NE by N	SE by S	33 45	SW by S	NW by N
			36 34		
			39 23		
			42 11		
4	NE	SE	45 0	SW	NW
			47 49		
			50 38		
			53 26		
5	NE by E	SE by E	56 15	SW by W	NW by W
			59 4		
			61 52		
			64 41		
6	ENE	ESE	67 30	WSW	WNW
			70 19		
			73 8		
			75 56		
7	E by N	E by S	78 45	W by S	W by N
			81 34		
			84 23		
			87 11		
8	E	E	90 0	W	W.

PROB.

PROB. II. Fig. 37.

Given the Course, and Difference of Latitudes: } *To find the Distance run, and Longitude:*

A *Ship from* { 10°.00′ *Latitude* / 2.10 *West Longit.* } *Sails N E by E to* 3°.36′ *of Latitude.*

By *Rule* I. the Difference of Latitude is 3°.36′, or 216 Miles.

1. As C, Compl. of the Course 33°.45′, on S,
is to A B, Differ. of Latitude 216 Miles, on D;
So is the Radius, 90°.00′, on S,
to A C, the *Distance run* 390 Miles, on D.

2. As C, the Compl. of the Course 33°.45′, on S,
is to A B, Differ. of Latitude 216 Miles, on D;
So is A, the Course 56°.15′, on S,
to B C, the *Departure* 324 *Miles*, on D.

Which reduced gives 5°.24′.

Therefore by 2. *Rule* VIII. the *Ship* is in 3°.14′ *West Longitude.*

If you suspect you have neglected the *Variation*, or that the care, or skill of the *Steersman* hath let her Yaw and fall off, then with the Difference of *Latitudes*, and the *Distance* run by *Prob.* III. find the *Course*, and *Departure*.

PROB.

PROB. III. Fig. 37.

Given the Distance run, and both Latitudes: } *To find the Course and Longitudes.*

A *Ship from* { 48°.00′ *South Lat.* } *Sails East* 408 *Miles to* 51°.30′ *South Latitude.*
{ 358.00 *Longitude* }

By *Rule* I. the Difference of Latitude is 3°.30′ or 210 Miles.

1. As A C, the Distance run 408 Miles, on D,
is to the Radius, 90°.00′, on S;
So is A B, the Differ. of Latit. 210 Miles, on D,
to C, *the Compl. of the Course* 30°.58′, on S.

Therefore A, the *Course* is 59°.2′ (*that is*) by *Rule* IX. S E by E 2°.47′ *Easterly*.

2. As the Radius 90°.00′, on S,
is to A C, the Distance, run 408 Miles, on D;
So is A, the Course 59°.2′, on S,
to B C, the *Departure* 348 *Miles*, on D.
(that is) 5°.48′.

Therefore by *Rule* VII. the *Ship* is in 3°.48′ of *Longitude*.

PROB.

PROB. IV. Fig. 37.

Given the Distance run, and both Latitudes: } *To find the Course, and Latitude.*

A *Ship from* { 46°.00′ *Nor. Latit.* } *Sails* 360 *Miles between the Nor. and the West to Longitude* 357°.
{ 352.00 *Longitude* }

By *Rule* V. the *Departure* is 300 Miles.

1. As A C, the Distance run 360 Miles, on D,
is to the Radius 90°.00′, on S;
So is B C, the Departure 300 Miles, on D,
to A, the *Course* 56°.27′, on S.
(*that is*) By *Rule* IX. N W by W, 00°.12′, *Westerly*,
2. As A, the Course 56°.27′, on S,
is to B C, the Departure 300 Miles, on D;
So is C, the Compl. of the Course 33°.33′, on S,
to A B, *Difference of Latit.* 198 Miles, on D.
Which reduced makes 3°.18′.
Therefore by 1 *Rule* III. the Ship is in 49°.18′ *North Latitude.*

PROB. V. Fig. 37.

Given the Course, and both Longitudes: } *To find the Distance run, and Lat.*

A *Ship from* { 2°.00′ *Nor. Latitude* } *Sails* S E *by* E. *to* 176°.21′ *West Longit.*
{ 178.00 *East Longit.* }

By

By *Rule* V. the Departure is 5°.39′ or 339 Miles.

1. As A, the Course 56°.15′, on S,
is to B C, the Departure 339 Miles, on D;
So is the Radius, 90°.00′, on S,
to A C, the *Distance run*, 408 *Miles*, on D.

2. As A, the Course 56°.15′, on S,
is to B C, the Departure 339 Miles, on D;
So is C, the Compl. of the Course 33°.45′, on S,
to A B, *Differ. of Latitude* 228 *Miles*, on D.
Which reduced makes 3°.48′.

Therefore by 2. *Rule* III. the *Ship* is in 1°.48′ *South Latitude.*

PROB. VI. Fig. 37.

Given both Latitudes, and both Longitudes: } *To find the Course, and Distance run.*

LET two Ports be in { 52°.00′ / 48.00 } *Nor. Lat.* and { 58°.00′ / 53.00 } *Longitude.*

By *Rule* { I, II, V } the { Differ. of Latitude is 4°.00′, or 240 Miles. / Course is Southward. / Departure is 5°.00′ or 300 Miles. }

1. As A B, the Differ. of Latit. 240 Miles, on D,
is to the Radius 45°.00′, on T;
So is B C, the Departure 300 Miles, on D,
to A, the *Course*, 51°.21′, on T.
(i. e.) By *Rule* IX. S W 6°.21′ *westerly*, or S W by W 4°.54′ *Southerly.*

2. As

2. As A, the Course 51°.21′, on S,
is to B C, the Departure 300 Miles, on D;
So is the Radius 90°.00′, on S,
to A C, the *Distance run* 384 *Miles*, on D.

Note, the Projection of the *Plain Chart* being erroneous, these *Rules* are to be used only in *small Distances* near the *Equinoctial*, where the Degrees of *Longitude* and *Latitude* are equal, *viz.* each 60 Degrees, but at a Distance from the *Equinoctial*, and in long Courses they fail much.

For if they be laid down true by the { *Course* and *Dist.* / *Course* and *Dep.* / *Distan.* and *Dep.* / *Latit.* and *Dep.* } the { *Depart.* will be false. / *Dist.* and *Diff.* of *Lat.* will be too much. / *Dif.* of *Lat.* will be too little and *Course* wide / *Course* will be *wide*, and *Dist.* too much.

Therefore tis best to use *Mercator's Chart.*

SECT. II.

Of Mercator's Sailing.

MErcator's (or more truly Mr. Wrights) *Sailing, shews the Ships motion on a Plain upon any Course, true both in Longitude, Latitude, and Distance; the Meridians being all Parallels, and the Parallels of Latitude strait Lines.*

PROB.

PROB. I.

Given the Latitudes of any two Places: } *To find their Meridional Difference in Degr. &c. or Miles.*

THis *Problem* hath three Cases.

1. *When one Place is under the Equinoctial, and the other towards one of the Poles.*

Let one Place be in 0.00′, and the other in 50°00′ of *Latitude.*

Find 50, the *Latitude* on the Line marked *Merid.* and against it on the *Equal parts* is 57°.9 or 57°.54′ the *Meridional Difference* (*that is*) 3474 Miles.

2. *When two Places have both North, or both South Latitude.*

Let the Places be in 50°.00′, and 15°.30′ *North Latitude.*

Find { 50°.00′ } on the Line *Merid.* } 57°.54′
{ 15.30 } and on *Equal parts* is } 15.41

Refts *Meridional Difference*, or *Lat. inlarged* 42 13 or 42°.22.

Which turned into *Miles* makes 2533.

3. *When two Places have one North, and the other South Latitude.*

Let the Places be in 30°.00′, and 36°.30′ *South Latitude.*

Find { 36°.30′ } on the Line *Merid.* } 39°.15′
{ 30.00 } and on eq parts is } 31.28

The Sum is the *Meridion. Differ.* 70.43 or 70°.72. (*that is*) 4243 *Miles.*

PROB.

PROB. II. Fig. 38.

Given the { *Latit. of two Places* { 50°.00′ / 15.30 } *Diff. of Long.* 68.30 } *To find the Course, and Distance.*

BY 2. *Prob.* I. the *Meridional Difference* is 42°.22.

1. As D E, the Differ. of Longitude, 68.5, on D,
is to the Radius, 45°.00′, on T;
So is A D, the Meridional Differ. 42°.22, on D,
to A, the Course 58°.20′, on T.
(i. e) By *Rule* IX. S W by W 2°.5′ *Westerly.*

2. As C, Compl. of the Course 31°.40′, on S,
is to A B, the true Diff. of Latit. 34°.5, on D;
So is the Radius 90°.00′, on S,
to A C, the *Distance run* 65°.46, on D.

PROB. III. Fig. 38.

Given the { *Latitudes of two Places* { 50°.00′ / 15.30 } *Distance run* 65.27 } *To find the Course, and Diff. of Lat.*

1. AS A C, the Distance run 65°.46, on D,
is to the Radius 90°.00′, on S;
So is A B, the true Differ. of Latitude, 34°.5, on D,
to C, the *Compl. of the Course* 31°.40′, on S.
Therefore A, the Course is 58°.20′.
By 2. *Prob.* I. the *Meridional Difference* is 42°.22.

2. As

2. As, the Course 58°.20′, on T,
is to A D, the Meridional Difference of Latitude 42°.22, on D;
So is the Radius 45°00′, on T,
to D E, the *Differ. of Longitude*, 68°.5, on D.

PROB. IV. Fig. 38.

Given the { *Latit.* { *Sailed from* 50°.00′ / *You are in* 15 30 } } *To find the Diff. of Long. and the Distance run.*
Course or Rumb 58.20

BY 2. *Prob.* II. the *Meridional Difference is* 42°.22.

1. As A, the Course 58°.20′, on T,
is to A D, the Merid. Differ. 42°.22, on D;
So is the Radius 45°.00′, on T,
to D E, the *Differ. of Longitude* 68°.5, on D.
2. By the 2. *Prob.* II. the *Distance run* is 65°.46.

PROB. V. Fig. 38.

Given the *Lat. you sailed from* 50°.00′, *Angle of the Course* 58.20, *Differ. of Longitudes* 68.30 — *To find the other Lat. and the Dist. run.*

1. AS the Radius 45°.00′, on T,
is to D E, the Diff of Long. 68°.5, on D;
So is A, the Course 58°.20′, on T,
to A D, the *Meridional Diff.* 42°.22, on D.

The

The Meridional Difference of 50°.00′ is . . . } 57°.54′
From which Subst. 42°.22. repreſenting . . . } 42.13

The Difference is . . . 15.41
Againſt which on the Line of *Equal parts* is . . } 15°.30′ the *Latitude.*

2. By the 2. *Prob.* II. the *Diſtance run* is 65°.46.

PROB. VI. Fig. 38.

Given the { *Lat. you Sail from* 50°.00′ N. / *Angle of the Courſe* 58.20 / *Diſtance run* . . 65.46 } *To find what Latitude you are in, and the Differ. of Longitudes.*

AS the Radius, 90°.00′, on S,
- is to A C the Diſtance run 65°.46, on D;
So is C, the Compl. of the Courſe 31°.40′, on S,
to A B, the true Differ. of Latit. 34.5, on D.

Then by 1. *Rule* III. 34.30 Subſtracted from 50°.00′. leaves 15°.30′ the Latitude required. The *Meridional Difference* of which two Latitudes is 42°.13′ or 42°.22.

And by 2. *Prob.* III. the *Difference of Longitude* is D E 65°.46.

PROB.

PROB. VII.

Given any Parallel of Latitude. } *To find how many Miles make one Degree of Longitude in that Parallel.*

EXample. *Let the Latitude be* 51°.32′.
As 90°.00′, the Radius, on S,
is to 60, the Miles in one Degree at the Equinoctial, on D;
So is 38°.28′, the Compl. of the Latitude, on S,
to 37°.2, the *Miles in one Degree of that Parallel*, on D.

PROB. VIII.

Given any Rumb: } *To find how many Miles make one Degree of Latitude in the Meridian, or in any great Circle.*

EXample. *Suppose you Sail on the Fourth Rumb from the Meridian.*
As 45°.00′, the Compl. of the Rumb, on S,
is to 60, the Miles in one Degree of a great Circle, on D;
So is 90°.00′, the Radius, on S,
to 85.3, the *Miles in one Degr. of Lat.* on D.

SECT.

SECT. III.

Of Circular Sailing.

Circular Sailing ſheweth how by a great Circle paſſing thro any two given Places the Ship may be directed by a skilful Mariner.

This is the neareſt, but the moſt difficult way of *Sailing*, and little uſed by *Mariners*, becauſe they can rarely keep their Courſe near this Arch, but are forced from it by *contrary Winds*, *Currents*, or interpoſition of ſome *head Lands*, or *Iſlands*, ſo that they generally keep their Account by *Mercator's way*: However were they skilful herein 'tis many times better to leave the *Rumb*, and to Sail more *Northerly* as in coming home from the *Weſt Indies*; alſo in a *Parallel Courſe*, as from the *Lizard* to *Newfound Land* by Raiſing and Depreſſing the Pole 10 or 12 Degrees, they may go a nearer way than to Sail on the *Parallel of Eaſt* and *Weſt*.

Note, if two Places lye under the { *Equinoctial* / *ſame Merid.* } their Poſition is { *E* and *W* / *N* and *S* } and the *Difference* of { *Lon.* / *Lat.* } is their *Diſtance*.

But if the *Latitudes* be of *contrary Denomination* their *Sum* is the *Diſtance*.

PROB. I. Fig. 3.

Given two Places { *One under the Equin.* 0°00′ / *the other in any Lat.* 50.00 / *Diff. of their Long.* 66.00 } *To find the nearest Distan. and Angles of Position.*

viz. The direct Position of the { *First* / *Second* } { *Places from the* } { *Second* / *First.* }

1. AS 90°.00, the Radius, on S,
is to 40°.00′, the Compl. of B C the Latitude, on SS,
So is 24°,00′, the Complement of A B the Difference of Longitude, on S,
to 15°.9′, Compl. of the nearest Dist, on SS.
Therefore A C 74°.51′ is the *Distance* on the Arches.

2. As 90°.00′, the Radius, on SS,
is to 40°.00′, the Complement of B C, the Latitude, on T;
So is A B 60°.00′, the Diff. of Long. on SS,
to 37°.28′, the Compl. of the Angle A, on T.
Therefore A 52°.32′ is the *Angle of Position of the first Place,*

3. As 90°.00′, the Radius, on SS,
is to 24°.00′, the Complement of A B the Difference of Longitude, on T;
So is AB, 50°.00′, the Latitude B C, on SS,
to 18°.50′, the Compl. of the Angle C, on T.
Therefore 71°.10′ is C the *Angle of Position of the Second Place.*

PROB.

PROB. II. Fig. 3.

Given two Places { *One under the Equin.* 1°.00′ / *the other in any Lat.* viz. 50.00 / *neareſt Diſtance* . . . 74.51 } *To find their Diff. of Longit. and Ang. of Poſition.*

As S 40°.00′, the Complement of B C the Latitude, on S,
is to 90°.00′, the Radius on SS;
So is 15°.9′, the Complement of A C the neareſt Diſtance, on S,
to 24°.00′, the Complement of A B the Difference of Longitude. on SS,
Therefore the *Difference of Longitude* A B is 66°.00′.
And by 2. and 3. *Prob.* I. you have the *Angles of Poſition.*

PROB. III. Fig. 4.

Given two Places in { *One Latitude*, viz. 50°.00′ / *Diff. of Longitude* 60.00 } *To find their Diſtance and Angle of Poſition.*

1. As S 90°.00′, the Radius, on S,
is to 40°.00′, the Complement of A C the Latitude, on SS,
So is 30°.00′, half A C B, the Semi-Difference of Longitude, on S,
to 18°.45′, half A B, the neareſt Diſt. on SS.
Therefore A B 37°.30′, is the whole *Diſtance* on the Arches.

2. As 90°.00′, the Radius, on SS,
is to half A C B the Semi-Difference of Longitude 30°.0′, on T;
So is A C 50°.00′, the Latitude, on SS,
to C A D 66°.08′, the *Angle of Position*, on T.

PROB. IV. Fig. 4.

Given two Places { *in one Lat.* viz. 50°.00′ / *Nearest Dist.* 37.30 } *To find their Differ. of Longitude and Angle of Position.*

AS 40°.00′, the Complement of A C the Latitude, on S.
is to 90°.00′, the Radius, on SS;
So is 18°.45′, half A B the nearest Dist. on S,
to 30°.00′ half A C B, the *Semi-Difference of Longitude*, on SS.
Therefore the whole *Longitude* is 60°.00′
And by 2. *Prob.* III. the *Angle of Position* C A D is 66°.08′.

Or thus, As A B 37°.30′, nearest Dist. on S,
is to A C B 60°.00′, the Diff. of Long. on SS;
So is 40°.00′, Compl. of A C the Latitude, on S,
to 66°.08′, the *Angle of Position* C A D, on SS.

PROB

PROB. V. Fig. 4.

Given two Places { *in the Latitudes* { 50°.00′ / 32.25 } ; *Diff. of Long.* 70.00 } *To find the neareſt Diſt. and Angles of Poſition.*

1. HAving A C 57°.35′, and B C 40°.00′, the Complement of the Latitudes, and the Angle A C B the Difference of Longitude 10°.00′ by *Prob.* XIX. of *Spherical Triangles*, you will find the *Side* A B, the *neareſt Diſtance* 53° 24.

2. By *Prob.* XVII. the *Angle* of *Poſition* C A B from Lat. 32°.25′ to 50°.00′. is 48°.48′ (*that is*) N E 3°.48′ *Eaſterly*.

3. By *Prob.* XVII. A B C, the *Angle* of *Poſition* from 50°.00′ to 32°.25′ is 81°.10′ (*that is*) W by N 2°.25′ *Weſterly*.

I might add many more *Problems* of *Circular Sailing*, but the Smalneſs of this *Tract* obliges me to leave their further proſecution to the Ingenious *Mariner*, to whom I heartily wiſh Proſperity in all his laudable Undertakings.

CHAP. XI.

Use of the Rule in Fortification.

FOrtification or Military Architecture is an Art which teacheth how to fortifie any Place, so that all its parts may mutually assist and defend each other against the Force and Assaults of an Enemy.

§. 1. *Of some Terms of Art, and of the chief Lines, and Angles used in any regular Fortification.* Fig. 38.

1. The *Rampire* or *Rampart* is a Mass of Earth heaped up to such a Thickness that it may be Cannon proof as K L O N F G, the *outward Line* of which at the foot next the Ditch is the *Basis* on which all the rest of the Lines depend

2. A *Bastion* or *Bulwark* is a Mass of Earth which advanceth its self towards the Field as N F G H T.

3. The *George Line* or Neck is *half the Entrance* into the *Bastion*, and terminates the Point C whereby the *Flank* shall be raised as N C.

4. The *Curtain* is that part of the *inward Polygon* which lies between the two *Bastions* B and C as N O.

5. The *Flank* is an *Out Line* of the *Bastion* which terminates the *Curtain*, and *Face* as N F, or O L.

6. The

6. The *Face* is the *outermoſt Line* of the *Baſtion*, as G F or K L.

7. The *Capital* or *Head Line* is a part of the *Line* drawn from the Centre A terminating at G the *flanked Angle*.

8. The *Side* of the inward or interior *Polygon* is B C.

9. The *Side* of the outward or exterior *Polygon* is K G.

10. The *Angle* of the *Baſtion*, or *flanked Angle* F G H.

11. The *ſecond Flank* is a part of the *Curtain*, as O P.

12. The *fixed* or *longeſt Line* of *Defence* is drawn from the Angle of the *Baſtion*, to the Angle of the *Flank* and *Curtain*, as G O.

13. The *flanking* or *ſhorteſt Line of Defence*, or *Line Stringent*, is drawn from the Angle of the *Baſtion*, to the Angle of the *ſecond Flank*, as G P.

14. The *Angle* of the *Eſpaule* or *Shoulder*, is formed by the *Face*, and *Flank* as G F N.

15. *Half Moons* are built before the Angles of the *Baſtions*, and arched in form of a Creſcent on thoſe Sides which lye towards the *Baſtions*, and are placed on the *Covert-way* beyond the *Ditch*, and ſometimes before the *Curtain*.

16. An *Horn work* is an Outwork which advances towards the Field, and carries in the Fore part two half *Baſtions* in the form of *Horns* which they preſent to the Enemy, and this muſt have ſmall *Rampires* and *Parapets*.

17. A *Ravelin* is a ſmall *Triangular* Work without Flanks, generally raiſed beyond the Ditch for the covering the *Curtain*, *Bridge*, or *Gate*, and is ſurrounded with Water, and built towards the Field

with a *Rampire* and *Breaſtwork*, but lies open to the Fortification.

18. *Cavaleers* or *Mounts* are great quantities of Earth raiſed between the *Georges* of the *Baſtion*, above the *Parapet*, on which Cannot, and ſmall Shot may be planted to ſcour the Field.

19. A *Crown Work* is a Work drawn beyond the *Horns* to keep the Enemy at a Diſtance.

20. *Counter Guards* are *Triangular* in form of a large *Parapet* which raiſe themſelves above the *Ditch* before the *Faces*, and Angles of the *Baſtion* to preſerve them.

21. The *Covert-Way* or *Corridor* is a *Walk* round about the *Ditch*, towards the Field having a *Foot-pace*, and a *Glacis* for a *Parapet*.

22. A *Redoubt* is a ſmall *Square Fort* having no Defence but in Front.

23. The *Glacis* is the *Parapet* of the *Covert-Way*, which loſeth its ſelf inſenſibly in the Field.

24. A *Parapet* is an Elevation of Earth upon the *Rampire*, behind which the Soldiers ſtand, and on which the Cannon are planted.

25. A *Gallery* is a *Walk* covered at top with about 1 $\frac{1}{2}$ Feet of Earth or Turf, and the Sides made with Planks lined with Iron Plates 8 or 10 Feet wide, and 9 Feet High, uſed in the *Ditch* when filled with *Faſſines* to preſerve the *Miners* in their approach to the *Baſtions*.

26. A *Platform* is a *place raiſed with Earth* on which they plant *Cannons*.

27. *Cazerns* are the *Lodgings* appointed for the *Officers*, and *Soldiers* when upon Duty.

28. The *Scarpe* is the *Slope* of the *Ditch* next the *Wall*.

29. The *Counterſcarpe* is the *Slope* of the *Ditch* next the *Field*.

Cazemats

30. *Cazemats* are made in the *Corners* of the *Flanks*, on which Guns are planted, to be hid from the Battery of the Enemy.

31. *Palliſadoes* are *wooden Stakes* about 3 Inches in *Diameter*, and 5 or 6 Feet in *Height*, pointed with Iron, and having 2 or 3 great Iron Nails driven through them towards the Head, 8 or 9 Inches long, theſe are fixed before the *Curtains*, *Rampires*, and *Glaces*.

32. A *Frieſland Horſe* is a *piece* of *Wood* about 6 Inches in *Diameter*, and 12 or 14 Feet in *Length*, with 6 *Sides* bored with Holes, one juſt under another on each *Side*, at about 6 Inches diſtance, into which are driven *wooden Pins* 5 or 6 Feet *Long*, pointed with Iron: They ſerve chiefly to ſtop the *Enemy* in the *Breaches*, and to ſecure the *Avenues* of the *Camp*.

33. *Mantelets* are *long Planks* about 3 Inches thick, nailed one over another, and filled up with Earth about 5 or 6 Feet in *Height*; theſe are movable, and ſerve to ſhelter the *Muſketeers*, and *Pioners* againſt the *ſmall Shot*.

34. *Chandileers* are *two thick pieces of Timber* about 6 Feet high, ſet upright at about 4 Feet diſtance, to be filled with *Bavins*. Theſe ſerve to cover the *Pioneers*, and hinder the beſieged from forcing them to quit their Labour.

35. *Faſſines*, or *Faggots*, are *ſmall branches of Trees, or Bavins bound up in Bundles*, which mixt with Earth ſerve to fill up the *Ditches*, and to form the *Parapets* of the *Trenches*.

36. *Gabions* are *Cylindrick Baskets* about 3 or 4 Feet in *Diameter*, and about 5 or 6 Feet in *Height* filled with Earth, and well rammed down; which ſerve to make the *Parapets* of *Batteries*, and *Lodgments*.

Small Gabions are *Cylindrick Baskets* about 12 Inches *Diameter* at *Top*, 8 or 10 at *Bottom*, and about 18 *High*; these are usually placed on low *Breastworks*, or when the *great Work* is beaten down.

37. *Crowfeet* or *Caltrops* are *four pointed Irons*, about 4 Inches long, so made that one Point always lies upwards, cast them which way you will.

38. The *Line* of *Contravallation* usually called *breaking of Ground* (if the Garrison be strong) is carried round the *Town* beyond *Falcon* Shot from it; This serves to keep them within, and to hinder their *Sallies* from hurting the *Besiegers*.

39. The *Line* of *Circumvallation* is carried round the *Camp*, enclosing Ground enough for all the *Army* to Lodge in: It must be about 10 or 12 Feet broad, and 4, 5 or 6 Feet deep, and above *Cannon* Shot from the Town, and well fortified.

This *Line* is seldom made except the Enemy hath an *Army* near, that may endeavour to raise the *Siege*.

§. 2. *Of some general Axioms in Fortification.*

1. The *form* of the *Fort* must be such that all its parts must *Flank* and be *Flanked* (*i. e.*) defend each other.

2. The *longest* or *fixed Line* of *Defence* must not exceed the reach of a *Musket Shot*, which is about 720 *Feet*.

3. *Every Side* of *a Fort* ought to have two *Flanks*, and if the *Curtain* be very Long, then it may have Four, and so there will be two *Flanks* near together, one to defend the Side towards the Right hand and the other the Side towards the Left, each *Flank* being Perpendicular to the *Curtain* that it flanks.

4. The

4. The *Baſtion* or *Bulwork* muſt be large enough to contain a ſufficient number of Men, and leave room for Traverſing the Guns, and other Military Duties.

5. The *Face* of the *Baſtion* muſt not be ſhorter than half the *Curtain*, nor longer than the Whole; The *Flank* muſt not be leſs than a fourth part of the *Face*; and the *George* muſt be near the ſame Length as the *Flank*.

6. The *Angle* of the *Baſtion* or *flanked Angle* muſt not be leſs than 60 *Deg.* nor much more than 90 *Deg.* Nor muſt the *outward flanking Angle* exceed 150 *Deg.*

7. The *inward flanking Angle* muſt be never leſs than 15 *Deg.* nor the Angle of the *Shoulder* of the *Baſtion* leſs than 105 *Deg.* the Difference of theſe two *Angles* being always 90 *Deg.*

8. The greater the *Angle* that is made by the *outward Polygon* and *Face*, the greater is the Defence of the Place.

9. The *Ditch* muſt be at leaſt 20 Fathoms broad, and as deep as poſſible. Now *Dry Ditches* about great Places are beſt becauſe they facilitate the *Sallies*, and *Retreat* of the *Beſieged*, but about ſmall Places *Wet Ditches* are beſt, becauſe *Sallies* are not neceſſary, and *Surpriſes* are to be feared.

§. Of

§. Of the Angles belonging to a regular Fort

Example. *Of a Pentagon.*

360 *Deg.* divided by 5 the number of Sides Quotes B A C the *Angle* at the *Center.*	72°.00'
Which Subſtracted from two right Angles or	180.00
Leaves the *Angle* of the *Fort*	108.00
The half of which is the *Angle* B C A . . .	54.00
To which always add-	15.00
The Sum is the *Angle* of the *Baſtion* F G H	69.00
The half of which is the *Angle* C G F . .	34.30
Which taken from half the Angle of the *Fort* B C A 54°. reſts the Angle of the *Curtain* or *inward flanking Angle* S G F = N P F	19.30
Whoſe Complement to 90°. is the Angle of the *Flank* S F O = N F P . . .	70.30
Which taken from two right Angles . ..	180.00
Leaves the Angle of the *Shoulder* of the *Baſtion* G F N	109.30
And the ſame Compl. S F G = I M G doubled is the *outward flanking Angle* K M C	141.00

If you would have the *Angle* at the *Baſtion* ſo to increaſe that in an *Octagonal* Fort it may be a *right Angle*, then make it *two thirds* of the *Angle* of the *Fort*; and F C N the *Angle* at the *George* which forms the *Flank* may be between 35 and 40 *Deg.*

§. 4. *To*

§. 4. *To find the Lines of a Fort by Trigonometry.* Fig. 38.

Example in a Pentagonal Fort the
Courtain . . . . . 420 } Feet.
Face of the Baſtion . . 280 }
Angle at the George . . 40 *Deg.*
Ordinary Angles as in §. 3.

I. *In the rectangled Triangle* F G S.

As the Radius 90°.00′, on S,
is to F G, Face of the Baſtion 280 Feet, on D;
So is S G F, inward flanking Angle 19°.30′, on S,
to the *Line* S F, 93.47 Feet, on D,
And ſo is the Angle G F S 70°.30′, on S,
to the *Line* G S 263.94, on D.
To which add I S . . . 210. Half the *Curtain*

The Sum is G I . . . 473.94 Half Side } Of the *outward Polygon.*
Which doubled is G K 947.88 the *Side* }

III. *In the rectangled Triangle* G A I.

As G A I, Semi-Angle at the Center 36°.00′, on S,
is to G I, the Semi-Side of the outward Polygon 473.94, on D;
So is the Radius, 90°.00′, on S,
to A G, the *Semi-Diameter* of the *outward Polygon*, 806.31, on D.
And ſo is B C A, the Semi-Angle of the Fort 54°.00′, on S,
to A I, the *Perpendicular* of the *outward Polygon* 652.32, on D.

III. *In*

III. *In the oblique angled Triangle.*

To the Semi-Angle of the Fort B C A . . . 54°.00′
Add the Angle at the George 40.00
Sum is 94° whose Complement to 180° is the Angle F G G . . . . . } 86.00

As the Angle F C G 86°.00′, on S,
is to the Face F G 280, on D;
So is C G F the Semi-Angle at the Bastion 34°.30′, on S,
to the *Line* C F 158.08, on D.

To C G F the Semi-Angle at the Bastion 34°.30′
Add the Angle F C G 86.00
The Sum is 120°.30′ whose Complement to 180°.00′ is the *Angle* C F G . . . . . } 59.30

As the Angle F C G 86°.00′, on S,
is to the Face F G 280, on D;
So is the Angle C F G 59°.30′, on S,
to the *Head Line* C G 241.84, on D.

Which taken from A G 806.31 } *Semi-Dia.* of the { *outwa.* / *inwar.* } *Polyg.*
The Remainder is 564.47

IV. *In the rectangled Triangle* C N F.

As the Radius 90°.00′, on S,
is to the Line F C 158.98, on D;
So is F C N, Angle at the George 40°,00′, on S,
to F N, the *Flank* 102.19, on D.
To which add S F . . 93.47

The Sum is S N = D I 195.66 the Diff. of the *Pentag.*
Which taken from A I 652.32 } *Perpend.* of the { *outw.* / *inwar.* } *Polyg.*
Leaves A D 456.66

As

As the Radius 90°.00′, on S,
is to the Line F C 158.98, on D;
So is 50°.00′, the Angle C F N, on S,
to N C the *George Line* 121.78, on D.
To which add N D half the Curtain 210.

The Sum is the Line D C . . . 331.78
Which doubled is . . . . . 663.56 *Side* of the *inward Polygon.*

V. *In the rectangled Triangle* F N P.

As N P F the inward flanking Angle 19°.30′, on S.
is to N F the Flank 102.19, on D;
So is the Angle N F P = G F S 70°.30′, on S,
to the *Line* N P 288.58, on D.
Which taken from N O . . 420. the *Curtain.*

Rests P O the *Second Flank* 131.42.

VI. *In the rectangled Triangle* G O R.

To the Line G S 263.94
Add the Curtain N O = R S . . . . 420.
The Sum is the *Line* G R 683.94
As the Line O R = I D 195.66, on D,
is to the Radius 90°.00′, on T;
So is the Line G R 683.94, on D,
to the *Angle* G O R 74°.2′, on T.
And as the Angle G O R 73°.2′, on S,
is to the *Line* G R, 683.94, on D;
So is the Radius 90°.00′, on S,
to the *Line* of *Defence* G O 711°.4′, on D.
And thus you may find the *Distances* D M, M P, *&c.*

CHAP.

CHAP. XII.

Uſe of the Rule in Gunnery.

GUnnery is an Art which teacheth how to Charge a Gun with Powder and Ball, which being fired may do execution at a due Diſtance either at Land or Sea.

§. 1. *Of ſome Terms of Art uſed in Gunnery.*

1. A *Gun* is a *Piece* of *Metal* caſt in a *Cylindrick* Form of a convenient Length, and Thickneſs, made hollow by Art and Proportion, the names of the chief parts of which are theſe:

1. The *outſide* round the Piece is the *Convex Superficies* of the *Metal*.

2. The *whole Maſs* of *Metal* is called the *Body*.

3. The *Caliber* is A B the *Height*, or *Diameter* of the *Bore*.

4. The *Hollowneſs* of the *Bore* from the Mouth to the Breech, is called the *Concave Cylinder*.

5. That part of the *Bore* towards the *Touch-hole*, which contains the *Powder*, *Shot*, and *Wad*, is the *Chamber* or *charged Cylinder*.

6. The *Ears* or *Knobs* as E E are called the *Trunnions*, and on theſe the Piece moves on the Carriage.

7. The *little Hole* which paſſeth from the *Convex Superficies* to the *Chamber*, made to give Fire to the Powder within as C, is called the *Touch-hole*.

8. All

8. All the *Metal* behind the *Touch-hole* is the *Breech* or *Coyle.*

9. The *Pummel* at the *Breech* as D, is the *Caſcabel.*

10. The *Baſe Ring* is the *Ring* at the *Breech* as K G L. The *Reinforc'd Ring* is that next above the Touch-hole, as N. The *Trunnion Ring* is next to that, as N. The *Corniſh Ring* is that between the *Trunnions* and *Muzzle*, as O. The *Treez* or *Muzzle Ring* is the uppermoſt at the *Muzzle*, as I. And the *Muzzle* is the Mouth or extremity of the *Chaſe*, by which you *Load* and *Unload* the *Gun.*

11. The *Line* of the *Cylinder* is a direct Line, ſuppoſed to be deſcribed along the *Chaſe*, parallel to the middle of it, as X Z.

12. The *Line of Metal* is a Line touching both Corniſhes, as M N I.

13. The *Diſpart Line* is the *Difference* between the *Semidiameter* of the *Muzzle*, and the *Baſe Ring*, as the Line I H.

14. The *Vent* of the *Piece* is the *Difference* between the *Diameter* of the *Shot*, and the *Mouth* of the *Piece*, as e d.

II. A *Mortar* is a *Piece* of *Metal* of a *Cylindrick* form but very Short and Wide, which ſerves for the throwing of *Bombs*, *Carcaſes*, &c. whoſe Carriage is uſually caſt with it, the Wheels of which are very low.

III. A *Bomb* is an *Iron Shell* longer one way than the other; with two Handles about 3 Inches long, filled with Powder, which will ſet Fire wherever it falls.

IV. A *Granado* is a *hollow Iron Sphere* filled with *Corn Powder*, with a *Fuſee* to fire the dry Powder, which breaks the *Shell* when it reacheth the deſigned Place into divers Pieces, and kills, or wounds many that are near it.

V. *Ca-*

V. *Carcaſes* are large *Granadoes* with Hooks to ſet Fire on every thing where they grapple, ſome of theſe are compoſed of 3 or 4 *Granadoes* with ſeveral *Petars*, and wrapt up in Tow dipt in oily Subſtances with a pitcht Cloth round about it: all theſe Materials are put into a kind of *Lanthorn* that hath a thin plate of Iron at each end faſtned by two *Iron Branches* a little leſs than the *Diameter* of the *Mortar* to which they belong, and croſſed by *Iron Circles* both at Top and Bottom to bear the force of *Powder* and fall of the *Carcaſe*, in one of theſe Plates is an Hole to fire the *Carcaſe*, which is forced into the Air like a *Bomb*.

VI. To *Tertiate a Gun* is to find the *Thickneſs* of the *Metal* at the *Touch-hole*, *Trunnions*, and *Muzzle*, now there are three ſorts of *fortified Cannon*.

1. A *Legitimate or ordinary fortified Cannon* hath	.875 .625 .375	at the *Touch-hole, Trunnions, Muzzle,*	Of the *Caliber* or *Diameter* of the *Bore* in *Thickneſs* of *Metal*.
2. A *Baſtard* or *leſſened Cannon* hath	.75 .562 .312		
3. A *double fortified Cannon* hath	1.000 .687 .437		

VII. *To Quadrate a Piece mounted* is to ſee whether it be *directly placed*, and *equally poiſed* in the *Carriage*, that is, to find by a Gunners Level in the *Convex Superficies* of the *Baſe*, and *Muzzle Ring* the *Point perpendicular* over the *Chamber*.

VIII. To

VIII. To *Diſpart a Piece* is to *ſet ſuch a Mark on*, or near the *Muzzle Ring* that a *viſual Line* taken upon the *top* of the *Baſe Ring* againſt the *Touch-hole*, by the *mark* on the *Muzzle Ring* may be *parallel* to the *Axis* of the *Chamber*, that is, with a pair of *Calliper Compaſſes* about 16 Inches long take the *Height* of the *Metal* at the *Breech*, and the *Height* of the *Metal* at the *Muzzle*, the *Semi-Difference* of theſe two is the *Diſpart*.

IX. The *greateſt Range* or *Random* is the *Range* of the *Shot* upon the *plain* of the *Horizon* when the *Piece* is elevated 45 *Degrees*.

Names of ſeveral Pieces of Ordnance uſed in England.	*Guns Wei.* *Pou.*	*Cha Len.* *Feet*	*Bore Dia.* *Inch*	*Bull. Weig* *Poun.*	*Poud. Weig* *lb ʒ*	*Great. Rang.* *Paces.*
A Rabinet.	120	3	1.25	.75	.5	3769
A Falconet.	210	4	2.	1.25	.9	4398
A Falcon.	700	6	2.75	2.25	1.10	4797
A Minnion.	1000	8	3.	4.	2.1	5864
A Saker.	1600	9.5	3.5	5.25	4.	5654
A Demi-Culver.	2600	10	4.5	9.	7.5	4886
A Culverin.	4000	11	5.	15.	10.	4837
A Demi-Cann.	6000	11	6.	27.	14.6	4031
A whole Connon.	7000	12	7.	47.	21.5	3769
A Cannon Royal.	8000	12	8.	63.	27.14	3298
Culv. Deal Caſtle		16	4.75		13.1	7407
Baſil. Dov. Caſtle		23.5	4.6		18.	11232

§. 2. *Of*

§. 2. *Of divers Problems in Gunnery.*

PROB. I.

Given 12 *Parts of Mercury,* 3 *Parts of Cole, and* 2 *Parts of Sulphur.* — *To find how much of each Ingredient is contained in* 1000 *l. of Powder?*

As 17, the *Sum* of all the *Parts*, on B, is to 1000, the given *Quant.* on A, so is

	on B to	on A, the Quantity of
12	706	*Merc.*
3	176.5	*Cole.*
2	117.5	*Sulph.*

And after this manner you may find how much of each *Metal* is contained in any *Brass Gun* whose *Weight* is given supposing that to every 100 *l.* of *Copper* you add 10 *l.* of *Latten*, and 8 *l.* of *Tin.*

PROB. II.

Given an Iron Ball whose Weight 9 *Pounds, Axis* 4 *Inches* — *To find the Weight of another Ball whose Axis is* 8 *Inches?*

As 4, one Axis, on C,
is to 9, its Weight, on E;
So is 8, the other Axis, on C,
to 72, its *Weight*, on E.

PROB.

PROB. III.

Given an Iron Ball whose Weight is 9 l: } *To find the Weight of a Leaden Ball of the same Axis?*

As 1.081, the Tabular number for Iron in p. 22, on B,
is to 9, the Weight as Iron, on A;
So is 1,554, the Tab. number for Lead, on B,
to 12.9, the *Weight* as *Lead.* on A.

PROB. IV.

Given an Iron Gun whose { *Caliber 3.5 Inches* / *Weig. 1600 Pounds* } *To find the Weig. of a Gun of the same Metal and Shape whose Caliber is 6 Inch.*

As 3.5, one Diameter of the Base, on C,
is to 1600, its Weight, on E;
So is 6, the other Diameter of the Bore, on C,
to 8061, its *Weight*, on E.

The Converse.

As 1600, one Weight, on E,
is to 3.5, its Diameter of the Bore, on C;
So is 8061, the other Weight, on E,
to 6, its *Diameter of the Bore*, on C.

PROB.

PROB. V.

Given an Iron Gun whose Weight is 1600 *l*: } *To find the Weight of a Braſs Gun of the ſame Caliber, and Length?*

As 1.081, the Tab. number for Iron, on B,
is to 1601, the Weight as Iron, on A;
So is 1.216, the Tab. number for Braſs, on B,
to 1800, the *Weight* as *Braſs*, on A.

PROB. VI.

Given an Iron Gun whoſe { *Weig.* 1600 *Pouns.* / *Caliber* 3.5 *Inches* } *To find the Weig. of a Braſs Gun of the ſame Shape whoſe Caliber is* 6 *Inches?*

By *Prob.* IV. the Weight as Iron was found to be 8061 *l.* then ſay,
As 1.081, the Tab. number for Iron, on B,
is to 8061, the Weight as Iron, on A;
So is 1.216, the Tab. number for Braſs, on B,
to 9068, the *Weight* as *Braſs*, on A.

PROB.

PROB. VII.

Given an Iron Ball whose Weight is 24 l. fit for a Cannon the Perifery of whose Breech is 9 Calibers: } *To find the Quantity of Powder fit for Proof, and Service.*

1. AS 1, on B,
is to 24, the Weight of the Ball, on A;
So is 9, the Calibers of the Breeches Perifery, on B,
to 216, a *fourth Number*, on A.

2. As 96 a fixed Number, on B,
is to 216, the fourth Number, on A;
So is 8, a fixed Number, on B,
to 18, the *Pounds* for *Proof*, on A.

And So is 6, another fixed Number, on B,
to 13.5, the *Pounds* for *Action*, on A.

PROB. VIII.

Given a Saker whose { *Calib. 3.5 Inches* / *Charge 4. Poun.* } *To find how much of the same Powder will Charge a Demi-Can. whose Calib is 6 Inches?*

AS 3.5, the Caliber of the Saker, on C,
is to 4, its Charge, on E;
So is 6, the Caliber of the Demi-Cannon, on C,
to 20.2, its *Charge*, on E.

Note,

Note, that the *Demi-Cannon* muſt bear the ſame Proportion to the *Saker* in *Weight*, as its *Caliber* bears to the *Caliber* of the *Saker*.

As Let the Weight of the Saker be 1600 *l.*

By *Prob.* IV. the Weight of the *Demi-Cannon* was found to be 8061. But if it weigh only 6000 *l.* then to find its due Charge, ſay:

As 8061, the Weight of the Demi-Cannon, on B,
is to 20.2, its Charge, on A;
So is 6000, the given Weight, on B,
to 15, its *Charge*, on A.

And if there be a ſtronger Powder than the former by ſuch Proportion as 5 to 2; How much of this ſort will Charge them.

1. As 5, on B,
is to 2 on A;
So is 4, the Saker's Charge in the firſt ſort, on B,
to 1.6, its *Charge* in the *Strongeſt Sort*, on A.

2. As 3.5, the Saker's Caliber, on C,
is to 1.6, its Charge, on E;
So is 6, the Demi-Cannon's Caliber, on C,
to 8.1, its *Charge*, on E.

Or as 5, on B,
is to 2, on A;
So is 20.2, the Demi-Cannon's Charge in the firſt Sort, on B,
to 8.1, its *Charge* in the *Strongeſt Sort*, on A.

PROB.

PROB. IX.

Given a Gun whose Horizontal Distance from the Mark is 700 Yards; now if her Mouth lye one Inch wide of the right Line to the Mark. } *To find how many Feet she will throw her Ball wide of the Mark?*

As 12, the Inches in one Foot, on B,
is to 3, the Feet in one Yard, on A;
So is 700, the given Distance in Yards, on B,
to 17.5, the *Feet the Ball will go wide*, on A.

PROB. X.

Given a Saker whose { *Elevation* 30.00 *Deg.* / *Greatest Ran.* 5654 *Pac.* } *To find the Horizontal Range.*

As 90°, double the Deg. of the greatest Range, on S,
is to 5654, the greatest Range, on D;
So is 60°, double the given Deg. of Elevat. on S,
to 4896, the *Horizontal Range* at 30°, on D.

Or by the Table of Horizontal Distances.

As 2000, the Tab. greatest Range, on B,
is to 5654, the Saker's greatest Range, on A;
So is 1732, the Tab. Distance of 30°, on B,
to 4896, the *Horizontal Range at* 30°, on A.

PROB. XI.

Given a Saker whose { *Elevation* 30.00 *Deg.* / *Horiz. Ran.* 4896 *Pac.* } *To find the greatest Range?*

As 60°, double the Deg. of Elevation, on S,
is to 4896, the given Range, on D;
So is 90°, double the Deg. of the greateſt Range, on S,
to 5654, the *greateſt Range*, on D.

Or by the Table of Horizontal Diſtances.

As 1732, the Tab. Diſtance of 30°, on B,
is to 4896, the given Range, on A;
So is 2000, the Tab. greateſt Range, on B,
to 5654, the *greateſt Range*, on A.

PROB. XII.

Given a Saker whoſe { *Greateſt Range* 5654 / *Horizon. Range* 4896 } *To find the Degrees of Elevation.*

As 5654, the greateſt Range, on D,
is to 90°, double the Deg. of the greateſt Range, on S;
So is 4896, the given Range, on D,
to 60, *double the Deg. of Elevation*, on S:

Or

Or by the Table of Horizontal Distances.

As 5654, the greatest Range, on B,
is to 2000, the Tab. greatest Range, on A;
So is 4896, the given Range, on B,
to 1732, the *Tab. Distance* of 30°, on A.

PROB. XIII.

Given a Mortar whose { *Elevat.* 15.00 *Deg.* / *Horiz. Range* 659 *Paces* } *To find the Deg. of Elevation to hit a Mark at the Horiz. Range of* 1000 *Pac.*

As 659, the given Distance, on B,
is to 5261, the Tab. Distance of 15°, on A;
So is 1000, the other Distance, on B,
to 7983, the *Tab. Distance of* 63°.16', or 25°.47', on A.

PROB. XIV.

Given a Mortar whose { *Range* 1000 *Paces* / *Elevat.* 63.16 *Deg.* } *To find the Range at* 15 *Deg. of Elev.*

As 7983, the Tab. Distance of 63°.16', on B,
is to 1000, the given Range, on A;
So is 5261, the Tab. Distance of 15°, on B,
to 659, the *Range required*, on A.

Note, that the *Charges* of *Powder* for like *Mortar-Pieces* are in Proportion as the *Cubes* of the *Diameters* of their *Bores*.

Horizontal Ranges for Long Guns to every Degree and 12 Min. or 2 Tenths of a Degree of the Quadrant in Paces of 5 Feet.

Deg.	.0	.2	.4	.6	.8	10	Dec.
Elev.	0	12	24	36	48	60	Min.
0	0	14	28	42	56	70	89
1	70	84	98	112	126	140	88
2	140	153	167	181	195	209	87
3	209	223	237	251	265	278	86
4	278	292	306	320	334	347	85
5	347	361	375	388	402	416	84
6	416	429	443	457	470	484	83
7	484	497	511	524	538	551	82
8	551	565	578	591	605	618	81
9	618	631	645	658	671	684	80
10	684	697	710	723	736	749	79
11	749	762	775	788	801	813	78
12	813	826	839	852	864	877	77
13	877	889	902	914	927	939	76
14	939	951	964	976	988	1000	75
15	1000	1012	1024	1036	1048	1060	74
16	1060	1072	1083	1095	1107	1118	73
17	1118	1130	1141	1153	1164	1176	72
18	1176	1187	1198	1209	1220	1231	71
19	1231	1242	1253	1264	1275	1286	70
20	1286	1296	1307	1317	1328	1338	69
Min.	60	48	36	24	12	0	Deg.
Dec.	10	.8	.6	.4	.2	0	Elev.

Hori-

Horizontal Ranges for long Guns to every Degree, and 12 Minutes, or two Tenths of a Degree of the Quadrant in Paces of 5 Feet.

Deg.	0	.2	.4	.6	.8	10	Dec.
Elev.	0	12	24	36	48	60	Min
21	1338	1349	1359	1369	1379	1389	68
22	1389	1399	1409	1419	1429	1439	67
23	1439	1448	1458	1467	1477	1486	66
24	1486	1496	1505	1514	1523	1532	65
25	1532	1541	1550	1559	1567	1576	64
26	1576	1585	1593	1601	1610	1618	63
27	1618	1626	1634	1642	1650	1658	62
28	1658	1666	1674	1681	1689	1696	61
29	1696	1703	1711	1718	1725	1732	60
30	1732	1739	1746	1753	1759	1766	59
31	1766	1772	1779	1785	1791	1798	58
32	1798	1804	1810	1816	1821	1827	57
33	1827	1833	1838	1844	1849	1854	56
34	1854	1860	1865	1870	1875	1879	55
35	1879	1884	1889	1893	1898	1902	54
36	1902	1906	1911	1915	1919	1923	53
37	1923	1926	1930	1934	1937	1941	52
38	1941	1944	1947	1950	1953	1956	51
39	1956	1959	1962	1965	1967	1970	50
40	1970	1972	1974	1976	1979	1981	49
41	1981	1982	1984	1986	1988	1989	48
42	1989	1990	1992	1993	1994	1995	47
43	1995	1996	1997	1998	1998	1999	46
44	1999	1999	2000	2000	2000	2000	45
Min.	60	48	36	24	12	0	Deg.
Dec.	10	.8	.6	.4	.2	0	Elev.

Hori-

Horizontal Ranges for Mortar Pieces to every Deg. and half of the Quadrant in Paces of 5 Feet.

Deg	0	30′	Deg	0	30′	Deg	0	30′
1	0711	0892	31	8930	9006	61	8431	8337
2	1069	1244	32	9079	9150	62	8240	8141
3	1417	1589	33	9219	9284	63	8040	7937
4	1759	1929	34	9346	9407	64	7830	7720
5	2097	2264	35	9464	9518	65	7609	7496
6	2431	2597	36	9569	9618	66	7380	7262
7	2763	2927	37	9664	9707	67	7142	7021
8	3090	3253	38	9747	9784	68	6896	6770
9	3415	3575	39	9818	9850	69	6642	6511
10	3754	3892	40	9878	9904	70	6379	6245
11	4050	4206	41	9926	9946	71	6109	5971
12	4361	4514	42	9962	9976	72	5832	5691
13	4665	4816	43	9987	9995	73	5547	5403
14	4966	5114	44	9999	10001	74	5257	5109
15	5261	5406	45	10000	9996	75	4959	4508
16	5550	5692	46	9989	9979	76	4656	4502
17	5832	5970	47	9966	9950	77	4347	4190
18	6107	6242	48	9931	9909	78	4033	3874
19	6375	6506	49	9884	9856	79	3714	3553
20	6635	6763	50	9825	9791	80	3391	3228
21	6889	7012	51	9755	9715	81	3063	2898
22	7134	7253	52	9673	9628	82	2732	2566
23	7370	7485	53	9579	9528	83	2398	2230
24	7598	7709	54	9475	9417	84	2061	1891
25	7817	7923	55	9358	9295	85	1721	1550
26	8027	8129	56	9230	9162	86	1397	1208
27	8227	8323	57	9091	9018	87	1036	0864
28	8418	8510	58	8942	8864	88	0691	0519
29	8599	8686	59	8782	8698	89	0346	0173
30	8769	8851	60	8612	8523	90	0000	0000

CHAP.

CHAP. XIII.

Use of the Rule in Dialling.

Dialling is an Art which teacheth how to measure the Time of the Day, by the Shade of the Sun.

§. 1. *Of some Definitions in Dialling.*

1. The *Gnomon*, or *Stile* is that which gives the *Shade*, and sheweth the *Hour*, and must be always *Parallel* to the *Axis* of the *world*.

2. The *Substile* is the *Line* on the *Plain* under the *Stile*.

3. *Declination* of a *Plain* is an *Arch* of the *Horizon* contained between the { *North* and *South* *Points*, and *East* and *West* *Points*, and } { a *Line* drawn *Perpendicular* to the *Plain*. the *Plain* itself. }

Note, if the *Declination* exceed { 90 / 180 } { Compl. to / Excess above } { 180° is the *Declination* from the *North*.

4. *Reclinat.* { is an *Arch* of a *Vertical Circle* contained between the { *Zenith* / *Horizon* } and the *Plain*.

5. *Inclinat.*

6. *Latitude* of a Place is an *Arch* of the *Meridian* contained between the *Pole* of the *World*, and the *Plain*.

7. *Inclination of Meridians* is an *Arch* of the *Equinoctial* comprehended between the *Meridian* of the *Plain*, and the *Meridian* of the *Place*: by some called the *Difference of Longitude*, because it shews in what *Longitude* from the *Meridian* of the *Plain* it will become an *Horizontal Dial*.

8. The *Substiles distance from the Meridian* is an *Arch* of the *Plain* contained between the *Meridian* of the *Plain*, and the *Meridian* of the *Place*.

§ 2. *Of the Denominations and Situations of the several Plains on which Dials are commonly made.*

Dials may be made on any *plain Superficies*, and all *Hour-Lines* (which are *great Circles* of the *Sphere*) drawn thereon, become *strait Lines*.

Now this *Art* consisteth chiefly in finding out of these *Lines*, and their *Distances* from each other, which continually vary according as the *Plains* on which they are described are situated in respect of the *Horizon* of the *Place*, and of these *Plains* there are but *three Varieties*, *viz*,

1. *Flat*, or *Parallel*, as is the *Horizontal* which *Faceth* the *Zenith*.

2. *Upright* or *Perpend* as { *Direct* { which *Face* the *North*, *South*, *East*, or *West Points* of the *Horizon*.
Declin. { which *Decline* from the *North*, or *South Points*, to the *East*, or *West*.

3. *Lean-*

3. *Leaning* or *Oblique* as { *Direct* { *South*, *North*, *East*, *West* } *Reclining* from the *Zenith*. / *Inclining* to the *Horizon*. ; *Declining* { *Reclining*. / *Inclining*. }

A *Declining Plain* is best represented by the *Side wall* of a *Church*, *House*, or any *Upright Building*, which doth not directly behold the *East*, *West*, *North*, or *South Points* of the *Horizon*.

A *Reclining Plain* is best represented by the *Outside* of the *Roof* of a *Church*, *House*, *Coaping* of a *Wall*, &c.

An *Inclining Plain* is best represented by the *Inside* of the *Roof* of a *Church*, *House*, &c.

PROB. I. Fig. 41.

How to draw Hour Lines on Horizon. Plains.

Example. *Suppose the Latitude* 51°.32'.

DRaw a Line cross the middle of the *Plain* for the *Meridian* or *Hour* of XII, which cross alike beyond the *Center* with the Line of E. and W. which is to be the *Hour* of VI. the intersection of these two Lines is the *Center* of the *Plain* on which draw an *occult Circle* for the drawing the *Hour Lines*, by which you must *Proportion* according to the given *Latitude*, thus:

As 90°, the Radius, on SS,
is to 15°, one Hour's Equinoctial Distance, from XII, on T;
So is 51°.32', the given Latitude, on SS,
to 14°.51', the *Distance* sought, on T.

Find the reſt of the *Equinoctial Diſtances* by the continual Addition of 15°, and by this *Canon* you may find all the reſt of the *Hour Diſtances* from XII, as in the *Table*.

The *Height* of the *Stile* is the *Latitude* of the Place. And the *Subſtile is the Meridian, or Hour of* XII.

Hours from Noon.	*Equinoctial Diſtances.*	*Hour Diſtan. on the Plain.*
	D. M.	D. M.
XII	0.00	0.00
XI. I	15.00	11.51
X. II	30.00	24.20
IX. III	45.00	38.03
VIII. IV	60.00	53.35
VII. V	75.00	71.06
VI.	90.00	90.00

PROB. II. Fig. 42, 43.

How to draw Hour Lines on upright Direct North or South Plains.

Example. *Suppoſe the Latitude* 51°.32'.

As 90°, the Radius, on SS,
is to 15°, one Hour's Equinoctial Diſtance on T;
So is 38°.28', Compl. of the Latitude, on SS,
to 9°.28', *Diſt. of the Hours* XI and I, on T.

And

And having the *Equinoctial* Degrees by a continual Addition of 15°. by this *Canon* all the *Hour Distances* were found as in the *following Table.*

The *Height* of the *Stile* must be equal to the *Complement* of the *Latitude.* The *Stile* must stand on the *Meridian.*

And on the { *North* / *South* } *Face* must Point to the { *North* / *South.*

Hours from Noon.	*Equinoctial Degrees.*	*Hour Distan on the Plain.*
	D. M.	*D. M.*
XII	0.00	0.00
XI.I	15.00	09.28
X.II	30.00	19.45
IX.III	45.00	31.54
VIII.IV	60.00	47.09
VII.V	75.00	66.42
VI.	90.00	90.00

PROB. III. Fig. 44, 45.

How to draw Hour Lines on Upright Direct East or West Plains.

FRom the lower Corner of the *Plain* according to the *Latitude* of the Place draw a Line Parallel to the *Equinoctial,* then towards the upper Side of the *Plain* draw another which shall cut the former at Right Angles, and point directly at the *Pole* of the *World.* This Line must stand for the *Hour*

of

of VI, and be the Place of the *Stile*, or *Sub-Stile*, then:

1. As the Hour Line of VI, on T,
is to the Radius, on SS;
So is the Distance thereof from the Merid. on T,
to the *Height* of the *Stile*, on SS.

2. As the Radius, on SS,
is to any Hours Distance from VI, on T;
So is the Stile's Height, on SS,
to the *Dist.* thereof from the Sub-Stile, on T.

PROB. IV. Fig. 46.

How to draw the Hour Lines on Upright North or South Plains, Declining East or West.

EXample. *Supppose it Decline from the South Westward* 30°. *in the Latitude of* 51°.32'.

Now in the making of this *Dial* you have made four,

viz. a { *South* / *North* } Declining { *West* / *East* / *East* / *West* } 30 *Deg.*

For by changing the *Hours*, and placing the *Sub-Stile* on the Contrary Side of the Line XII you have a *South Dial Declining East* 30°.

Then if you turn these two *Dials* upside down, you have two *North Declining Dials*, one *East*, the other *West* 30°, the *Stile*, *Substile*, and *Hour Distances* being the same in all four *Plains*; but in the two *North Decliners*, the *Stile* must Point Upwards

wards towards the *North Pole*, as the *South Decliners*, do *South* towards the *South Pole*, and to remove all Doubts concerning this matter (which is very material for a *Dialiſt* to be be perfect in) I have drawn the *Hour Lines* of the two *South Decliners* thro the Centers, and they produce the two *North Decliners*, only the *Hours* before IV in the Morning, and after VIII at Night are omitted, the *Sun* being then under our *Horizon*, ſo that XII being drawn thro the Center will be XII at Midnight.

1. *Find the Height of the Stile above the Plain thus:*

As 90°, the Radius, on S,
is to 38°.28′, the Complement of the Latitude, on SS;
So is 60°., the Compl. of the Declination, on S,
to 32°.36′, the *Stile's Height*, on SS.

2. *Find the Sub-Stile's Diſtance from the Meridian.*

As 90°, the Radius, on SS,
is to 38°.28′, the Compl. of the Latit. on T;
So is 30°, the Declination, on SS,
to 21°.40′, the *Sub-Stile's Diſtance* from the *Meridian*, on T.

3. *Find the Inclination of Meridians or Plain's Difference of Longitude.*

As 51°.32′, the Latitude on SS,
is to 30°.00′, the Declination, on T;
So is 90°.00′, the Radius, on SS,
to 36°.25′, *Inclination* of *Meridians*, on T.

Which

Which converted into *Time* by allowing 15° for one *Hour*, gives 2 *Hours* and 6°.25′ over, therefore the *Substile* (which is the *Meridian* of the *Plain*) must ſtand between the *Hours* of II and III.

Then prepare a *Table* of *Hours* proper for the *Plain* thus:

Againſt XII ſet 36°.25′, the *Inclination* of *Meridians*, from which Subſtract 15°. the Reſidue is 21°.25′, which place againſt XI and I, from 21°.25′ Subſtract 15° the Remainder is 6°.25′ which place againſt X and II. and becauſe it is leſs than 15°, write *Sub-Stile*, and Subſtract 6°.25′ from 15°, and there Remains 8°.35′, which place againſt IX and III, then by a continual Addition of 15° you will have the *Diſtance* of each *Hour* in *Equinoctial Deg.* as in the *Table*:

Then to find the Hour Diſtances on the Plain.

As 90°, the Radius, on SS,
is to 8°.25′, the Diſtance of the next Hour to the *Sub-Seile*, on T;
So is 32°.36′, the Stile's Height, on SS,
to 3°.28′, the *Diſtance* of the *Hours* X or II from the *Sub-Stile*, on T.
And ſo of the reſt as in the following *Table*.

Hours

Hours for the East. West.	*Equinoctial Distances.*	*Hour Distan. on the Plain.*
	D.M.	*D.M.*
V.VII	68.35	53.57
VI	53.35	36.08
VII.V	38.35	23.16
VIII.IV	23.35	13.14
IX.III	8.35	4.36
	Sub-Stile.	
X.II	6.25	3.28
XI.I	21.25	11.56
XII	36.25	21.41
I.XI	51.25	34.03
II.X	66.25	51.00
III.IX	81.25	74.21

PROB. V. Fig. 47.

How to draw Hour Lines on Direct East or West Plains Reclining from the Zenith towards the Horizon.

EXample. *Suppose a Direct West Plain should Recline from the Zenith* 35°, *in the Latitude of* 51°.32'.

Before the *Hour Distances* can be calculated you must find these Requisites.

1. For

1. *For the Height of the Stile above the Plain.*

As 90°, the Radius, on S,
is to 51°.32′, the Latitude, on SS;
So is 35°.00′, the Reclination, on S,
to 26°.41′, the *Stile's Height*, on SS.

2. *For the Sub-Stile's Diſtance from the Meridian.*

As 35°.00′, the Reclination, on T,
is to 90°.00′, the Radius, SS;
So is 26°.41′, the Stile's Height, on T,
to 45°.52′, the *Sub-Stile's Diſtance from* XII, on SS.

3. *For the Inclination of Meridians or Plains Difference of Longitude.*

As 51°.32′, the Latitude, on S,
is to 90°.00′, the Radius, on SS;
So is 45°.52′, Sub-Stiles Diſtance from XII, on S,
to 66°.27′, the *Inclination of Merid.* on SS.

Which converted into *Time* gives 4 Hours and 6°.27′ over, wherefore the *Sub-Stile* in the *Eaſt Dial*, muſt ſtand between IV and V, and in the *Weſt* between VII and VIII between which write *Sub-Stile.*

Then prepare a Table of Hours for the Plain thus.

Againſt the *Hours* of IV and VIII ſet 6°.27′, alſo Subſtract 6°.27′ from 15°.00′ the Remainder is 8°.23′, which place againſt V and VII, and by a continual Addition of 15° you will have the *Diſtance* of each *Hour* as in the *Table.*

Hours

Hours from the Subſtile.	*Equinoctial Diſtances.*	*Hour Diſtan. from Subſtile:*
	D. M.	*D. M.*
XII	81.27	71.29
XII	66.27	45.52
I.XI	51.27	29.24
II.X	36.27	18.20
III.IX	21.27	10.00
IV.VIII	6.27	2.54
	Subſtile.	
V.VII	8.33	3.52
VI.VI	23.33	11.04
VII.V	38.33	19.41
VIII.IV	53.33	31.18
IX.III	68.33	48.49
X.II	83.33	75.50

Then find the Hour Diſtances on the Plain from the Subſtile.

As 90°.00′, the Radius, on SS,
is to 6°.27′, Equin. Diſt. for IV and VIII, on T;
So is 26°.41′, the Stiles Height, on SS,
to 2°.54′, the *Diſtance of* IV *and* VIII *from the Subſtile*, on T.

And thus you may find the reſt of the *Hour Diſtances* as in the *Table.*

PROB. VI. Fig. 48, 49.

How to draw Hour Lines on Direct South Reclining Plains.

THis Problem hath two Varieties.

I. *If the Reclination be leſs than the Complement of Latitude.*

Exa mple.

Example. *Suppose a Direct South Plain Reclining from the Zenith* 25°.00′ *in the Latitude of* 51°.32′.

From 38°.28′, the Complement of the *Latitude* Subſtract 25°.00′ the *Reclination*, the Remainder 13°.28′ is the *Stiles Height* above the *Plain*.

Then prepare a *Table* with *Hours* and *Equinoctial Diſtances* anſwerable thereto, and find the *Hour Diſtances* from the *Meridian* by the general *Proportion*:

As 90°.00′, the Radius, on SS,
is to 15°.00′, Equinoctial Diſtance of one Hour, on T;
So is 13°.28′, the Stiles Height, on SS,
to 3°.34′, *Hour Diſtances of* XI *and* I, on T.

And ſo for all the reſt of the *Hour Diſtances* as in the *Table*. The *Difference* between the *Complement* of the *Latitude* and the *Reclination* is the *Stiles Height* above the *Plain*.

And the *Sub-Stile* is always the *Meridian*, or *Hour Line of* XII.

Hours from Noon.	*Equinoctial Diſtances.*	*Hour Diſtan. on the Plain.*
	D. M.	*D. M.*
XII	0.00	0.00
XI.I	15.00	3.34
X.II	30.00	7.39
IX.III	45.00	13.07
VIII.IV	60.00	21.58
VII.V	75.00	41.00
VI	90.00	90.00

II. *If the Reclin. be more than the Compl. of Lat.*

Example. *Suppoſe it be a Direct South Plain Reclining from the Zenith* 70°.00′, *in the Latitude of* 51°.32′.

From

From the *Reclination* 70°.00′ Subſtract 38°.28′ the Complement of *Latitude*, the Remainder 31°.32′ is the *Stiles Height* above the *Plain*.

Which known, prepare a *Table* and calculate the *Hour Diſtances*, from the *Meridian* by the general *Analogy*.

As 90°.00′, the Radius, on SS,
is to 15°.00′, Equin. Diſt. for 1 Hour, on T;
So is 31°.32′, the Stiles Height, on SS,
to 7°.59′, *Hour Diſtances* of XI and I, on T.

And ſo for all the reſt of the *Hour Diſtances* as in the *Table*.

Hours from Noon.	*Equinoctial Diſtances.*	*Hour Diſtan. on the Plain.*
	D.M.	D.M.
XII	0.00	0.00
XI.I	15.00	7.59
X.II	30.00	16.48
IX.III	45.00	27.36
VIII.IV	60.00	42.10
VII.V	75.00	62.52
VI	90.00	90.00

PROB. VII. Fig. 50, 51.

How to draw Hour Lines on Direct North Reclining Plains.

THis Problem hath two Varieties.

I. *If the Reclination be leſs than the Complement of Latitude.*

Example. *Suppoſe a Direct North Plain Reclining from the Zenith 25°.30′ in the Latitude of 51°.32′.*

To

To 25°.00′. the *Reclination* add 38°.28′ the Complement of *Latitude* the Sum is 63°.28′ the *Height* of the *Stile* above the *Plain.*

If the *Sum* exceeding 90°. then take its Compl. to 180°.

Then prepare a *Table* and find the *Hour Distances* from the *Meridian* by the general *Canon.*

As 90°.00′, the Radius,
is to 15°.00′, one Hours Equinoctial Distance, on T;
So is 63° 28′, Stiles Height above the Plain, on SS,
to 13°.29′, *Hour Distance* of XI and I, on T.

And after this manner you may find all the *Hour Distances* as in the *Table.*

Hours from Noon.	*Equinoctial Distances.*	*Hour Distan on the Plain.*
	D.M.	D.M.
XII	0.00	0.00
XI.I	15.00	13.29
X.II	30.00	27.19
IX.III	45.00	41.49
VIII.IV	60.00	57.10
VII.V	75.00	73.20
VI	90.00	90.00

II. *If the Reclination be more than the Complement of Latitude.*

Example. *Suppose a Direct North Plain should Recline from the Zenith* 70°.00′ *in the Latitude of* 51°.32′.

To 20°.00′ the Complement of the *Reclination* add 51°.32′ the *Latitude* the Sum is 71°.32′ the *Stiles Height* above the *Plain.* Then the *Hour Distances* may be found by the general *Canon.*

As

As 90°.00′, the Radius, on SS,
is to 15°.00′, one Hours Equinoctial Distance, on T;
So is 71°.32′, the Stiles Height, on SS,
to 14°.16′, *Hour Distances* of XI and I, on T.

And repeating this operation you will find all the *Hour Distances* as in the following *Table*.

Hours from Noon.	*Equinoctial Distances.*	*Hour Distan. on the Plain.*
	D.M.	*D.M.*
XII	0.00	0.00
XI.I	15.00	14.16
X.II	30.00	28.43
IX.III	45.00	43.30
VIII.IV	60.00	58.41
VII.V	75.00	74.14
VI.	90.00	90.00

PROB. VIII. Fig. 52, 53.

How to draw Hour Lines on South Declining Reclining Plains.

THis Problem hath three Varieties.

I. *Of South Declining Reclining Plains, the Plain passing thro the Pole of the World.*

Example. *Suppose a South Plain Declining Eastward* 30 *Deg. and Reclining from the Zenith* 34°.32′ *in the Latitude of* 51°.32′.

1. *For the Diſtance of the Merid. from the Horizon.*

As 90°.00′, the Radius, on S,
is to 38°.28′, the Compl of Latitude, on SS;
So is 30°.00′, the Declination, on S,
to 18°.7′, the Compl. of the Diſtance, on SS.
Therefore 71°.53′, is the *Diſtance of the Meridian.*

2. *For the Inclination of Meridians.*

As 38°.28′, the Compl. of Latitude, on S,
is to 90°.00′, the Radius, on SS;
So is 34°.32′, the Reclination, on S,
to 65°.41′, the *Compl. of Inclination*, on SS.
Therefore the *Inclination* is 24°.19′.

II. *Of South Declining Reclining Plains, the Plain paſſing between the Pole of the World, and the Zenith.*

Example. *Suppoſe a South Plain Declining Eaſtward* 30°.00′, *and Reclining from the Zenith* 20°.00′.

Before the *Hour Lines* can be found, you muſt find theſe *Requiſites.*

1. *For the Diſt. of the Merid. from the Horizon.*

As 90°.00′, the Radius, on SS,
is to 30°.00′, the Declination, on T;
So is 20°.00′, the Reclination, on SS,
to 11°.10′, the Compl. of the Diſtance, on T.
Therefore 78°.50′ is the *Diſtance* of the *Meridian* and *Horizon.*

2. *For*

2. *For the Height of the Stile above the Plain.*

As 30°.00′, the Declination, on S,
is to 11°.10′, the Complement of Meridian Diſtance, on SS;
So is 90°.00′, the Radius, on S,
to 22°.47, a *fourth Arch*, on SS.
Which taken from 38°.28′, the *Complement of Latitude* there reſts 15°.41′ a *fifth Arch*.
As 22°.47′, the fourth Arch, on S,
is to 20°.00′, the Reclination, on SS;
So is 15°.41′, the fifth Arch, on S,
to 13.49, the *Stiles Height*, on SS.

3. *For the Sub-Stiles Diſtance from the Meridian.*

As 20°.00′, the Reclination, on T,
is to 11°.10′, Compl. of Merid. Diſt. on SS;
So is 13°.49′, the Stiles Height, on T,
to 7°.30′, the *Sub-Stiles Diſtance* from the *Meridian*, on SS.

4. *For the Inclination of Meridians.*

At 15°.41′, the fifth Arch, on S,
is to 90°.00′, the Radius, on SS;
So is 7°.30′, the *Sub-Stiles Diſtance from the Meridian*, on S,
to 28°.52′, *Inclination* of *Meridians*, on SS.
Which converted into *Time* is 1 *Hour*, and 13°.52′ over, wherefore the *Plain Declining Eaſtward*, the *Stile* muſt ſtand between X and XI in the Forenoon, then prepare a *Table*, and ſet down the *Hours* the *Plain* is capable to receive, *viz.* from 5 in the Morning till 4 in the Afternoon, and between the

Hours

Hours of X and XI where the *Sub-Stile* must ſtand write *Sub-Stile*, and under it 13° 52′, which take from 15°.00′, the Remainder 1°.08′ place over *Sub-Stile*, then by the continual Addition of 15°.00′ to theſe two Numbers you have the Numbers in the *Table*.

And the *Hour Diſtances* are found by the general *Analogy*.

As 90°.00′, the Radius, on SS,
is to 76°.8′, the Equinoctial Diſtance of V and VII, on T;
So is 13°.49′, the Stiles Height, on SS,
to 44°.3′, the *Diſtance* of V and VII from the *Sub-Stile*, on T.

And thus you may find every *Hours Diſtance* as in the *Table*.

Hours from Noon.	*Equinoctial Diſtances.*	*Hour Diſtan. on the Plain.*
	D.M.	*D.M.*
V.VII	76.08	44.03
VI	61.08	23.25
VII.V	46.08	13.57
VIII.IV	31.08	8.12
IX.III	16.08	3.57
X.II	1.08	0.16
	Sub-Stile.	
XI.I	13.52	3.22
XII	28.52	7.30
I.XI	43.52	12.55
II.X	58.52	21.34
III.IX	73.52	39.32
IV.VIII	88.52	85.16

III. *Of South Declining Reclining Plains, the Plain passing between the Pole of the World, and the Horizon.*

Example. *Suppose a South Plain Declining Eastward* 30°.00′ *and Reclining from the Zenith* 55°.00′.

Before you can draw the *Hour Lines* you must find these *Requisites.*

1. *For the Distance of the Meridian from the Horiz.*

As 90°.00′, the Radius, on SS,
is to 30°.00′, the Declination, on T;
So is 55°.00′, the Reclination, on SS,
to 25°.19′, a *fourth Arch*, on T.

Whose Complement 64°.41′ is the *Distance* of the *Meridian* from the *Horizon.*

2. *For the Height of the Stile above the Plain.*

1. As 90°.00′, the Radius, on SS,
is to 35°.00′, Compl. of the Reclinat. on T;
So is 60°.00′, Compl. of the Declination, on SS,
to 31°.14′, a *fourth Arch*, on T.

Which Substracted from 51°.32′ the *Latitude* leaves 20°.18′ a *fifth Arch.*

2. As 64°.41′, Dist. of the Merid and Horiz on S,
is to 60°.00′, Compl. of Declination, on SS;
So is 20°.18′, the fifth Arch, on S,
to 19°.25′, the *Stiles Height*, on SS.

3. *For the Sub-Stiles Distance from the Meridian.*

As 70°.35′, Compl. of the Stiles Height, on S,
is to 90°.00′, the Radius, on SS;
So is 69°.42′, Compl. of the fifth Arch, on S,
to 83°.58′, Compl. of the *Sub Stiles Dist.* on SS.

Therefore 6°.02′ is the *Sub-Stiles Dist.* from XII.

4. *For the Inclination of Meridians.*

As 20°.18′, the fifth Arch, on S,
is to 90°.00′, the Radius, on SS;
So is 6°.02′, Sub-Stiles Diſtance from XII, on S,
to 17°.38′, the *Inclinat. of Meridians*, on SS.

Which is 1 *Hour*, and 2°.38′ over, therefore (becauſe the *Plain Declineth Eaſtward*) the *Stile* muſt ſtand between the *Hours* of X and XI in the Forenoon; then prepare a *Table* and ſet down all the *Hours* the *Plain* is capable to receive, *viz.* from 5 in the *Morning* till 4 in the *Afternoon*, and between X and XI write *Sub-Stile*, and under it the Remainder 2°.38′ againſt XI and I, which Subſtract from 15°.00′, and the Reſidue 12°.22′ place over *Sub-Stile* againſt X and II then by the continual Addition of 15°.00′ to theſe Numbers above and below the *Sub-Stile* you have the Numbers in the *Table*.

And the *Hour Diſtances* are found by the general *Proportion*.

As 90°.00′, the Radius, on SS,
is to 42°.22′, the Equinoctial Diſtance of VIII and IV. on T;
So is 19° 25′, the Stiles Height, on SS,
to 16°.52′, *Diſtance* of thoſe *Hours* from the *Sub-Stile*, on T.

And ſo for all the reſt of the Numbers as in the *Table*.

Hours

Hours from Noon.	*Equinoctial Distances.*	*Hour Distan. on the Plain.*
	D.M.	*D.M.*
V.VII	87.22	82.07
VI	72.22	46.17
VII.V	57.22	27.26
VIII.IV	42.22	16.52
IX III	27.22	9.46
X.II	12.22	4.10
	Sub-Stile.	
XI.I	2.38	0.53
XII	17.38	6.02
I.XI	32.38	12.01
II.X	47.38	20.01
III.IX	62.38	32.42
IV.VIII	77.38	56.35

PROB. IX. Fig. 54, 55, 56.

How to draw Hour Lines on North Declining Reclining Plains.

THis Problem hath three Varieties.

I. *Of North Declining Reclining Plains, the Plain passing thro the intersection of the Meridian and Equinoctial.*

Example. *Suppose a North Plain Declining Westward* 60°.00′, *and Reclining from the Zenith* 32°.11′.

1. *For the Dist. of the Meridian from the Horizon.*

As 90°.00′, the Radius, on SS,
is to 60°.00′, the Declination, on T;
So is 32°.11′, the Reclination, on SS,
to 42°.42′, a *fourth Arch*, on T.

Whose Complement 47°.18′ is the *Distance* of the *Meridian* and *Horizon*.

2. *For the Height of the Stile above the Plain.*

As 42°.42′, the fourth Arch, on SS,
is to 32°.11′, the Reclination, on T;
So is 90°.00′, the Radius, on SS,
to 42°.52′, the *Stiles Height*, on T.

The *Distance* of the *Sub-Stile* from the *Meridian*, and the *Inclination* of *Meridians* are each 90°.00′.

And the *Hour Distances* are found as in an *Horizontal Plain*. Wherefore prepare a *Table* setting the *Equinoctial Degrees* against their proper Hours, and then by the general *Canon*.

As 90°.00′, the Radius, on SS,
is to 15°.00′, the first Hours Distance, on T;
So is 42°.52′, the Stiles Height, on SS,
to 19°.20′, *Distance* of V and VII from VI the *Sub-Stile*, on T.

And so for all the rest as in the *Table*.

Hours

Hours from Noon.	Equinoctial Distances.	Hour Distan on the Plain.
	D.M.	D.M.
VI.	0.00	0.00
VII V	15.00	10.20
VIII IV	30.00	21.27
IX III	45.00	34.14
X II	60.00	49.41
XI I	75.00	68.30
XII	90.00	90.00

II. *Of North Declining Reclining Plains, the Plain passing between the Zenith, and the Equinoctial.*

Example. *Suppose a North Plain Declining Westward* 60°.00′, *and Reclining from the Zenith* 16°.00′.

1. *For the Distance of the Merid. from the Horiz.*

As 90°.00′, the Radius, on SS,
is to 60°.00′, the Declination, on T;
So is 16°.00, the Reclination, on SS;
to 25°.31′, the Compl. of the Distance, on T

Therefore 64°.29′ is the *Distance* of the *Meridian* and *Horizon*

Note, if the *Declination* exceed 45° as in this *Example*, then find it on T, and see what Number stands against it on SS, then say:

As 35°.30′, the Number against 60°.on SS,
is to 45°.00′, the Radius, on T;
So is 16°.00′, the Reclination, on SS,
to 25°.31′, a *fourth Arch*, on T.

Whose Complement 64°.19′ is the *Distance* of the *Meridian* and *Horizon*.

2. *For the Height of the Stile above the Plain.*

As 60°.00′, the Declination, on S,
is to 90°.00′, the Radius, on SS;
So is 25°.31′, the Complement of Diſtance of Meridian and Horizon, on S,
to 29°.50′, a *fourth Arch*, on SS.
To which add 38°.28′, the Complement of *Latitude*, the Sun is 68°.18′ a *fifth Arch*, then:
As 29°.50′, the fourth Arch, on S,
is to 16°.00′, the Reclination, on SS;
So is 68°.18′, the fifth Arch, on S,
to 30°.59′, the *Stiles Height*, on SS.

3. *For the Sub-Stiles Diſtance from the Meridian,*

As 16°.00′, the Reclination, on T,
is to 25°.31′, the Complement of Diſtance of Meridian and Horizon, on SS;
So is 30°.59′, the Stiles Height, on T,
to 64°.26′, the *Sub-Stiles Diſtance*, on SS.

4. *For the Inclinations of Meridians.*

As 30°.29′, the Stiles Height, on SS,
is to 64°.26′, Sub-Stiles Diſtance from the Meridian, on T;
So is 90°.00′, the Radius, on SS,
to 76°.10′, the *Inclination of Meridians*, on T.
Which converted into *Time* is 5 *Hours*, and 1°.10′ over, wherefore the *Sub-Stile* muſt ſtand, between the V and VI *Hours*, write *Sub-Stile*, and under it 1°.10′ againſt VII and V, which Subſtract from 15°.00′ and there reſts 13°.50′, which ſet over *Sub-Stile* againſt VI and VI, then by a continual addition

on of 15°.00′ to the Numbers next above and below the *Sub-Stile* you ſhall produce the *Equinoctial Diſtances* as in the *Table*, from which the *Hour Diſtances* may be found by the general *Analogy*, For:

As 90°.00′, the Radius, on SS,
is to 88°.50′, Equin. Diſt. for I and XI, on T;
So is 30°.59′, the Stiles Height, on SS,
to 87°.44′, the *Diſtance* of I and XI from the *Sub-Stile*, on T.

And ſo of the reſt as in the following *Table*.

Hours from the Subſtile.	*Equinoctial Diſtances.*	*Hour Diſtan. from Subſtile.*
	D.M.	D.M.
I.XI	88.50	87.44
II X	73.50	60.37
III.IX	58.50	40.24
IV.VIII	43.50	26.18
V.VII	28.50	15.49
VI.VI	13.50	7.13
	Sub-Stile.	
VII.V	01.10	0.36
VIII.IV	16.10	8.29
IX.III	31.10	17.18
X.II	46.10	28.12
XI.I	61.10	43.05
XII.XII	76.10	64.26

III. *Of North Declining Reclining Plains, the Plain paſſing between the Equinoctial and the Horizon.*

Example. *Suppoſe a North Plain Declining Eaſtward* 60°.00′, *and Reclining from the Zenith* 54°.00′.

1. *For the Distance of the Merid. from the Horizon.*

As 90°.00′, the Radius, on SS,
is to 60°.00′, the Declination, on T;
So is 54°.00′ the Reclination, on SS,
to 54°.29′, the Compl. of the *Distance*, on T.

Therefore 35°.31′ is the *Distance* of the *Meridian* and *Horizon*.

2. *For the Height of the Stile above the Plain.*

As 60°.00′, the Declination, on S,
is to 90°.00′, the Radius, on SS;
So is 54°.29′, Co-Distance of Mer. and Hor. on S,
to 70°.02′, a *fourth Arch*, on SS.

To which add 38°.28′, the Complement of *Latitude*, the Sum is 108°.30′, whose Complement to 180°.00′ is 71°.30′ *a fifth Arch*.

As 70°.02′, the fourth Arch, on S,
is to 54°.00′, the Reclination, on SS;
So is 71°.30′, the fifth Arch, on S,
to 54°.43′, the *Stiles Height* on SS.

3. *For the Sub-Stiles Distance from the Meridian.*

As 54°.00′, the Reclination, on T,
is to 54°.29′, Co-Distance of Meridian and Horizon, on SS;
So is 54°.43′, the Stiles Height, on T,
to 56°.42′, the *Substiles-Distance*, on SS.

From the *North* part of the *Meridian*, whose Complement to 180°.00′ is 123°.18′. its *Distance* from the *South* part thereof.

4. For

4. *For the Inclination of Meridians.*

As 54°.43′, the Stiles Height, on SS,
is to 56°.42′, Sub-Diſtance from Mer. on T;
So is 90°.00′, the Radius, on SS,
to 61°.48′, *Inclination of Meridians*, on T.

Counted from the *North*, whoſe Complement to 180°.00′ is 118°.12′ the *Inclination* reckoned from the *South* part of the *Meridian*. Now 61°.48′ converted into *Time* gives 4 *Hours* and 1°.48′ over, wherefore the *Sub-Stile* muſt be placed between the Hours of IV and V, write *Sub-Stile*, and over it the Remainder 1°.48′ againſt IV and VIII which Subſtract from 15°.00′, and there reſts 13°.12′, which ſet under *Sub-Stile* againſt V and VII, then by a continual Addition of 15°.00′ to both theſe Numbers you have the *Equinoctial Diſtances* as in the *Table*, and thoſe by the general *Canon* will give you the *Hour Diſtances*, For:

As 90°.00′, the Radius, on SS,
is to 28°.12′, the Equinoctial Diſtance for VI, on T;
So is 54°.43′, the Stiles Height, on SS,
to 23°.39′, *Diſtance of* VI *from Sub-Stile*, on T.

And ſo for all the reſt of the *Hour Diſtances*, as in the *Table*.

Hours

Hours from the Substile.	*Equinoctial Distances.*	*Hour Distan. from Substile.*
	D. M.	*D. M.*
XI.I	76.48	73.57
XII	61.48	56.41
I.XI	46.48	40.51
II.X	32.48	26.50
III.IX	16.48	13.50
IV.VIII	1.48	1.27
	Substile.	
V.VII	13.12	10.51
VI.VI	28.12	23.39
VII.V	43.12	37.29
VIII.IV	58.12	52.48
IX.III	73.12	69.43
X.II	88.12	87.49

And all these may be transferred from this *Table* to the *Plain* by help of a Line of *Chords*, which I leave to the *Practice* of the *Ingenious*, my *Business* here being (not to teach the whole *Art* of *Dialling*) but to shew the excellent use of the *Proportional Lines* on the *Rule*.

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WHereas *great Abuſes are committed by Ignorant Pretenders to the Making of* Mathematical Inſtruments, *who know nothing of the Reaſon thereof, to the Scandal of* Art *and* Artiſts, *as well as Damage to the Publick*; *eſpecially in ſuch* Inſtruments *as relate to* Gauging. *I thought good to Advertiſe ſuch as may have Occaſion, that they may be furniſhed with Exact* Inſtruments *for any part of the* Mathematicks, *in* Silver, Braſs, Ivory *or* Wood, *by* Iſaac Carver (*the Original Maker of the* Inſtrument *deſcribed in this Book, as well as ſeveral others Relating to this purpoſe*) *who lives at the Sign of the* Globe-Dial *on* Horſlydown, *in* Southwark, *near* London.

Books

Hours from the Substile.	*Equinoctial Distances.*	*Hour Distan. from Substile.*
	D. M.	*D. M.*
XI.I	76.48	73.57
XII	61.48	56.41
I.XI	46.48	40.51
II.X	32.48	26.50
III.IX	16.48	13.50
IV.VIII	1.48	1.27
	Substile.	
V.VII	13.12	10.51
VI.VI	28.12	23.39
VII.V	43.12	37.29
VIII.IV	58.12	52.48
IX.III	73.12	69.43
X.II	88.12	87.49

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